



ES201 THE MEDITERRANEAN: A PLASTIC SEA

IES Abroad Milan

DESCRIPTION:

The primary aim of this course is to provide a current and comprehensive overview on issues related to plastic pollution at a global level, focusing on plastic accumulation in the Mediterranean Sea. The course explores the many open questions concerning the accumulation, distribution and fate of plastic litter and implications for marine wildlife and humans. A historical synopsis of marine pollution research is provided to appreciate the rapid development of this research field, especially in relation to microplastics. The various primary and secondary sources of microplastics and the pathways through the environment to the ecosystem are examined. Due to the small size and variety of plastic polymers, the detection, identification, and quantification of microplastics are challenging at present; for this purpose, a critical appraisal of the main methods and procedures for the sampling of plastic litter and its composition are evaluated and applied to a specific case study. Chemical, biological, and ecological implications of plastic pollution are also analyzed to allow students to evaluate the deleterious effects on marine wildlife.

The course prepares students to read scientific literature in a critical and objective way, considering the comparability of results obtained from different studies. It provides a deep understanding of the magnitude of plastic pollution in surface waters of the Mediterranean basin as well as a comparison with plastic accumulation in open oceans. The course also covers other specific topics such as plastic aging and degradation; propagation over trophic levels of the marine food web; toxicants associated with plastic debris and how they may affect marine life and human health. The course will show how the problem of plastic pollution will be framed into SDGs and the Metabolism of cities concept. The course also considers how plastics compare with other anthropogenic pollutants in terms of ecological risk and the role of society in tackling this matter, with a special focus on procedures to reduce the input of litter into oceans.

CREDITS: 3

CONTACT HOURS: 45

LANGUAGE OF INSTRUCTION: English

PREREQUISITES: none

METHOD OF PRESENTATION:

Lessons include lectures (using slides and videos), class discussions, case studies and field studies.

REQUIRED WORK AND FORM OF ASSESSMENT:

Grade Breakdown:

- Class engagement 10%
- Short essay (3-4 page + presentation) 20%
- Midterm exam 20%
- Group Lab/workshop 10%
- Reflection paper: 25%
- Final Exam (presentation of Reflection paper) 15%

Course Engagement

A rubric for course participation will be posted on Moodle and shared with students at the beginning of the term.

Short essay

Students will prepare a research essay on one of the topics covered in the course. The essay should be concise yet informative. The written assignment is due on week 5, session 2, by 23.59pm. Students who submit their papers after the deadline will lose 4 percentage-points from the essay's grade. The paper should be a maximum of 1500 words in length (3-4 pages), Times New Roman font (12pt) and should be submitted both electronically (to the Professor's e-mail) and in paper format to the instructor in class. The short paper will be presented in class with the preparation of a short slidedeck.

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Group Lab/workshop

Students will participate into a group work connected to a topic in which they are asked to cooperate in a role-play game with other students in finding out a solution to a posed problem. Students will be evaluated on their engagement on the activity and ability to cooperate to find innovative solutions.

Reflection paper

Students will analyse and reflect on a specific topic, supporting it with their observations as well as using scientific concepts acquired during the course. The reflection paper is due at week 10, session 3, by 23.59pm. Students who submit their papers after the deadline will lose 4 percentage points from the paper's grade. The reflection paper should be a maximum of 3000 words in length (4-8 pages), Times New Roman font (12pt) and should be submitted both electronically (to the Professor's e-mail) and in paper format to the instructor in class.

Midterm exam

Written test with both multiple-choice and open-ended questions.

Final exam

Oral Presentation of the reflection paper.

Students are requested to give a presentation to the class on their research topic (maximum of 10 minutes per student).

LEARNING OUTCOMES:

By the end of the course, students will be able to:

- Develop the concept of plastic as a complex and dynamic structure that changes its bioavailability
- Outline and discuss scientific concepts and methodological approaches concerning plastic sampling
- Identify the chemical, biological, and ecological factors that may affect marine ecosystems and human health
- Define the plastic pollution issue in areas with high human pressure, such as the Mediterranean Sea
- Analyze and evaluate data from scientific outputs
- Define and appreciate the specific contribution of Italian researchers to the international field of plastic characterization
- Discuss and critically evaluate the ecological risks associated with plastic pollution
- Identify the initiatives in tackling this global issue

ATTENDANCE POLICY:

As a member of our class community, you are expected to be present and on time every day. Attending class has an impact on your learning and academic success. For this reason, the IES Abroad Milan attendance policy allows for the following number of absences, which are intended to be used for physical and mental health reasons:

- THREE (3) absences in each Italian language course,
- **TWO (2) absences in each Area Studies course,**
- ONE (1) absence in each seminar course or course meeting 1 day a week,
- ZERO (0) absences in each course of individual music instruction.

Every absence beyond this allowance will automatically result in a penalty of 2 percentage points off the final grade. SEVEN (7) absences will result in a failing grade in Italian language and Area Studies courses. FOUR (4) absences will result in a failing grade in seminar or 1-day-a-week courses. Failure to attend a scheduled exam, test, quiz, or presentation will automatically result in an F grade on that assessment.

ACADEMIC INTEGRITY:

Students are expected to abide by the IES Abroad Code of Academic Integrity. All work submitted by a student for academic credit should constitute the student's own original work. Any work submitted for academic credit may be subject to review by a textual similarity detection service for the detection of plagiarism and AI usage.

CONTENT:

Week	Content	Assignments
Week 1 <i>Session 1</i>	Introducing plastic pollution - Distribution and composition - The plastic problem - Monitoring and awareness	- Galgani F., Hanke G., Maes T. (2015) Global Distribution, Composition and Abundance of Marine Litter. In: Bergmann M., Gutow L., Klages M. (eds) Marine Anthropogenic Litter, pp. 29-56 https://oceanliteracy.unesco.org/plastic-pollution-ocean/ - CIEL (2019). Plastics & Climate: The hidden costs of a plastic planet. [Recommended]
<i>Session 2</i>	The Mediterranean Sea: A Case Study - The problem of plastic in the Mediterranean - Bioaccumulation - Different types of pollutant in the Mediterranean	- Cozar A, Sanz-Martin M, Marti E, González Gordillo JL, Ubeda B, Gálvez JA, et al. (2015) Plastic Accumulation in the Mediterranean Sea. (9 pages) - Suaria, G. et al. (2016) The Mediterranean Plastic Soup: synthetic polymers in Mediterranean surface waters. (10 pages) - Sharma S, Sharma V and Chatterjee S (2021) Microplastics in the Mediterranean Sea: Sources, Pollution Intensity, Sea Health, and Regulatory Policies. (20 pages) (recommended)
Week 2 <i>Session 1</i>	The Fate of Plastics Entering the Oceans An Emerging Pollutant: Microplastics Guest lecture: Carol Maione, Metabolism of Cities Living Lab, San Diego State University	- Andrady A.L. (2015) Persistence of Plastic Litter in the Oceans. Pp. 57-72 . - Ogunola OS, Palanisami T (2016) Microplastics in the Marine Environment: Current Status, Assessment Methodologies, Impacts and Solutions. (13 pages) M. Cole, P. Lindeque, C. Halsband, T. S. Galloway (2011), Microplastics as contaminants in the marine environment: A review, pp 2588-2597. [Recommended]
<i>Session 2</i>	Sampling Methods and Errors - The problem of monitoring of microplastic - Current state of art of the monitoring of microplastic - Future trends	Danielle S. Green, Louise Kregting, Bas Boots, David J. Blockley, Paul Brickle, Marushka da Costa, Quentin Crowley (2018), A comparison of sampling methods for seawater microplastics and a first report of the microplastic litter in coastal waters of Ascension and Falkland Islands. Pp. 695-701
Week 3 <i>Session 1</i>	Visit to the Civic Aquarium of Milan	https://www.acquariodimilano.it/ https://www.divegozo.co.uk/mediterranean-sea-flora-and-fauna
<i>Session 2</i>	Physical, Chemical, and Biological Effects of Microplastics - Bioaccumulation concept - Toxicological Effect of Microplastic on the short and long term - Prevention - Intervention	- Duis and Coors (2016) Microplastics in the aquatic and terrestrial environment: sources (with a specific focus on personal care products), fate and effects. (36 pages) J. Wang et al. (2016), The behaviors of microplastics in the marine environment. pp. 7-17 [Recommended]

Week 4 <i>Session 1</i>	Microplastic from the environment to human health: a One-health concept	- Vaccari, Filippo, et al. "Effects of micro and nanoplastics on soil fauna gut microbiome: An emerging ecological risk for soil health." <i>Current Opinion in Environmental Science & Health</i> 30 (2022): 100402. - Banni, M., Jebali, J., Daubeze, M., Clerandau, C., Guerbej, H., Narbonne, J. F., & Boussetta, H. (2005). Monitoring pollution in Tunisian coasts: application of a classification scale based on biochemical markers. <i>Biomarkers</i>, 10(2-3), 105-116. - Zitouni, N., Bousserhine, N., Missawi, O., Boughattas, I., Chèvre, N., Santos, R., ... & Banni, M. (2021). Uptake, tissue distribution and toxicological effects of environmental microplastics in early juvenile fish <i>Dicentrarchus labrax</i>. <i>Journal of Hazardous Materials</i>, 403, 124055.
<i>Session 2</i>	Ingestion of Plastics: A Critical Appraisal on a Case Study Case Studies of ingestion of Plastic on animal and humans	- Rochman C.M. (2015), The Complex Mixture, Fate and Toxicity of Chemicals Associated with Plastic Debris in the Marine Environment. pp. 117-140. - Compa M et al. (2018) Ingestion of microplastics and natural fibres in <i>Sardina pilchardus</i> (Walbaum, 1792) and <i>Engraulis encrasicolus</i> (Linnaeus, 1758) along the Spanish Mediterranean coast, pp. 89-96 M. Steer, M. Cole, R. C. Thompson, P. K. Lindeque (2017). Microplastic ingestion in fish larvae in the western English Channel. pp. 250-259.
Week 5 <i>Session 1</i>	The Role of Plastics as Vector for Pollutants - Basic understanding of co-pollution mechanisms - Plastic-carriers concepts	Caruso, G. (2019). Microplastics as vectors of contaminants. <i>Marine pollution bulletin</i>, 146, 921-924.
<i>Session 2</i>	Student short essay presentations Midterm review	Jahnke et al. (2017) Reducing Uncertainty and Confronting Ignorance about the Possible Impacts of Weathering Plastic in the Marine Environment. pp. 85-90 Galloway, T., Cole, M. & Lewis, C. Interactions of microplastic debris throughout the marine ecosystem. (8 pages)
Week 6 <i>Session 1</i>	MIDTERM	
<i>Session 2</i>	An Experimental Approach to Study the Chemical Behavior of Plastics Physical and Chemical	Pittura L, Avio CG, Giuliani ME, d'Errico G, Keiter SH, Cormier B, Gorbi S and Regoli F (2018) Microplastics as Vehicles of Environmental PAHs to Marine Organisms: Combined Chemical and

	Hazards cause by plastic and Microplastic PAH spread and associated risks	Physical Hazards to the Mediterranean Mussels, <i>Mytilus galloprovincialis</i> . (15 pages) F. Rendell-Bhatti et al. (2021) Developmental toxicity of plastic leachates on the sea urchin <i>Paracentrotus lividus</i>. (17 pages)
Week 7 <i>Session 1</i>	Interactions Between Microorganisms and Marine Plastics - The Influence of Biofilms - Ecotoxicology of plastic and microplastic	J. P. Harrison et al. (2011) Interactions Between Microorganisms and Marine Microplastics: A Call for Research. pp. 12-20. - Kiessling T., Gutow L., Thiel M. (2015) Marine Litter as Habitat and Dispersal Vector, pp. 141-181.
<i>Session 2</i>	"SDGs, Urban metabolism and MFA models for plastic flows," Guest lecture: "SDGs, Urban metabolism and MFA models for plastic flows," Dr. Gabriela Fernandez, Professor at San Diego State University	Chini, C. M., & Stillwell, A. S. (2019). The metabolism of US cities 2.0. <i>Journal of Industrial Ecology</i>, 23(6), 1353-1362.
Week 8 <i>Session 1</i>	(Re-think) Reduce, Re-use, Recycle: Creating Awareness about Plastic Waste Management - Basic understanding of circularity - The 3(4)R mantra applied on Plastic Wastes	- WWF Report 2019: A Guide for Policy Makers in Italy https://wwfeu.awsassets.panda.org/downloads/06062019_wwf_italy_guidebook.pdf (25 pages) - Bucknall, D. G. (2020). Plastics as a materials system in a circular economy. (Recommended)
<i>Session 2</i>	Legislation and Regulation of Marine Plastic Debris - The international regulatory Framework on Plastic - The regional and national regulatory frameworks on plastic	- Chen CL. (2015) Regulation and Management of Marine Litter. pp 395-428. F. Thevenon et al. (2014) Plastic Debris in the Ocean. International Union for Conservation of Nature. pp 35-38.
Week 9 <i>Session 1</i>	An Appraisal of Single-use Plastic: Directive on Their Reduction - The EU regulatory framework on plastic - The EU regulatory framework declined at state level	- European Commission (2018). A European Strategy for Plastics in a Circular Economy. - Moving away from single-use. Guide for national decision makers to implement the single-use plastics directive. (56 pages) [Recommended]
<i>Session 2</i>	How to Reduce Plastic Pollution: An Overview of Possible Solutions	M. Ericksen et al. (2018) Microplastic: What Are the Solutions? <i>Freshwater Microplastics</i>, pp 273- 298
Week 10 <i>Session 1</i>	Group Lab/workshop	Löhr, K., Weinhardt, M., & Sieber, S. (2020). The "World Café" as a participatory method for collecting qualitative data. <i>International journal of qualitative methods</i>, 19, 1609406920916976.

		- Kirsch, S. (2021). Talanoa Dialogue at UN Climate Change Meetings: The Extraordinary Encompassment of a Scale-Climbing Pacific Speech Genre. <i>Oceania</i>, 91(3), 330-348. - Hoyt, C. R., Houston, A. J., Harris, K. M., Millsap, M., Pearson, A. C., Taff, S. D., & Connor, L. T. (2021). OpenSpace Technology. <i>Journal of Best Practices in Health Professions Diversity</i>, 14(1), 25-35.
Session 2	Project description: Citizen Science initiatives for Coastal protection, Race X Oceans and From Trash2Treasure Presentation of the citizen science case studies Race X Ocean and From Trash 2 Treasure by Metabolism of Cities Living Lab Guest Lecturer: Teresa Romeo Director, Biological Zoological Station, Anton Dhorn, Amendolara, Italy	- Maione, C., Fernandez, G., Vito, D., Marsaglia, L., Cortez, M., Buurste, C. (2022). Protecting Our Oceans with Citizen Science - Fritz S, See L, Carlson T, Haklay MM, Oliver JL, Fraisl D, Mondardini R, Brocklehurst M, Shanley LA, Schade S, Wehn U (2019) Citizen science and the United Nations sustainable development goals. pp. 922–930. https://youtu.be/FcTJnZI_6kI?list=PLFMANCAC_0v-c9KS1uCSH5FR3Xj0g_9
Week 11 Session 1	Quantitative Analysis of Plastic Debris on Beaches - Example of Beach Litter Debris Analysis - Lab Class: analysis of Microplastic - General Course review	H.B. Jayasiri, C.S. Purushothaman, A. Vennila (2013) Quantitative analysis of plastic debris on recreational beaches in Mumbai, India. pp. 107-112.
Session 2	Course-related trip: Anthropeano/Fagnana - Visit the ArtWork - Interview With the Author	
		Deadline for reflection paper submission
Finals Week	Final Exam	

REQUIRED READINGS:

- Cozar A, Sanz-Martin M, Marti E, González-Gordillo JI, Ubeda B, Gálvez JA, et al. (2015) Plastic Accumulation in the Mediterranean Sea. *PLoS ONE* 10(4): e0121762. doi:10.1371/ journal.pone.0121762
- Dannielle S. Green, Louise Kregting, Bas Boots, David J. Blockley, Paul Brickle, Marushka da Costa, Quentin Crowley (2018) A comparison of sampling methods for seawater microplastics and a first report of the microplastic litter in coastal waters of Ascension and Falkland Islands. *Marine Pollution Bulletin*, Volume 137, pp 695-701, ISSN 0025-326X, <https://doi.org/10.1016/j.marpolbul.2018.11.004>
- Di Bartolo, Alberto, Giulia Infurna, and Nadka T. Dintcheva (2021). "A Review of Bioplastics and Their Adoption in the Circular Economy" *Polymers* 13, no. 8: 1229. <https://doi.org/10.3390/polym13081229>
- Duis and Coors (2016) Microplastics in the aquatic and terrestrial environment: sources (with a specific focus on personal care products), fate and effects. *Environ Sci Eur*, 28:2 DOI 10.1186/s12302-015-0069-y
- Eriksen M., Thiel M., Prindiville M., Kiessling T. (2018) Microplastic: What Are the Solutions?. In: Wagner M., Lambert S. (eds) *Freshwater Microplastics. The Handbook of Environmental Chemistry*, vol 58. Springer, Cham.

https://doi.org/10.1007/978-3-319-61615-5_13

- F. Rendell-Bhatti et al. (2021) Developmental toxicity of plastic leachates on the sea urchin *Paracentrotus lividus*. *Environmental Pollution*, Volume 269, 115744, ISSN 0269-7491, <https://doi.org/10.1016/j.envpol.2020.115744> • F. Thevenon et al. (2014) Plastic Debris in the Ocean. *International Union for Conservation of Nature*. pp 35-38 DOI: 10.2305/IUCN.CH.2014.03.en
- Galgani F., Hanke G., Maes T. (2015) Global Distribution, Composition and Abundance of Marine Litter. In: Bergmann M., Gutow L., Klages M. (eds) *Marine Anthropogenic Litter*. Springer, Cham. pp. 29-56 https://doi.org/10.1007/978-3-319-16510-3_2
- Galloway, T., Cole, M. & Lewis, C. Interactions of microplastic debris throughout the marine ecosystem. *Nat Ecol Evol* 1, 0116 (2017). <https://doi.org/10.1038/s41559-017-0116>
- H.B. Jayasiri, C.S. Purushothaman, A. Vennila (2013) Quantitative analysis of plastic debris on recreational beaches in Mumbai, India. *Marine Pollution Bulletin*, Volume 77, Issues 1–2, Pages 107-112, ISSN 0025-326X, <https://doi.org/10.1016/j.marpolbul.2013.10.024>
- J. P. Harrison et al. (2011) Interactions Between Microorganisms and Marine Microplastics: A Call for Research. *Marine Technology Society Journal* 45(2):12-20 DOI: 10.4031/MTSJ.45.2.2
- J. Wang et al. (2016) The behaviors of microplastics in the marine environment. *Marine Environmental Research* 113 (2016) 7-17 <https://dx.doi.org/10.1016/j.marenvres.2015.10.014>
- Kiessling T., Gutow L., Thiel M. (2015) Marine Litter as Habitat and Dispersal Vector. In: Bergmann M., Gutow L., Klages M. (eds) *Marine Anthropogenic Litter*. Springer, Cham. https://doi.org/10.1007/978-3-319-16510-3_6
- Lambert S. (2015) Biopolymers and Their Application as Biodegradable Plastics. In: Kalia V. (eds) *Microbial Factories*. Springer, New Delhi. https://doi.org/10.1007/978-81-322-2595-9_1
- M. E. Grigore (2017) Methods of recycling, properties and applications of recycled thermoplastic polymers. *Recycling*, 2, 24; doi:10.3390/recycling2040024
- M. Ericksen et al. (2018) Microplastic: What Are the Solutions? In book: *Freshwater Microplastics* DOI: 10.1007/978-3-319-61615-5_13
- Ogunola OS, Palanisami T (2016) Microplastics in the Marine Environment: Current Status, Assessment Methodologies, Impacts and Solutions. *J Pollut Eff Cont* 4: 161. doi:10.4172/2375-4397.1000161
- Pittura L, Avio CG, Giuliani ME, d'Errico G, Keiter SH, Cormier B, Gorbi S and Regoli F (2018) Microplastics as Vehicles of Environmental PAHs to Marine Organisms: Combined Chemical and Physical Hazards to the Mediterranean Mussels, *Mytilus galloprovincialis*. *Front. Mar. Sci.* 5:103. doi: 10.3389/fmars.2018.00103
- Rochman C.M. (2015) The Complex Mixture, Fate and Toxicity of Chemicals Associated with Plastic Debris in the Marine Environment. In: Bergmann M., Gutow L., Klages M. (eds) *Marine Anthropogenic Litter*. Springer, Cham. https://doi.org/10.1007/978-3-319-16510-3_5
- Suaria, G. et al. (2016) The Mediterranean Plastic Soup: synthetic polymers in Mediterranean surface waters. *Sci. Rep.* 6, 37551; doi:10.1038/srep37551
- WWF Report 2019: A Guide for Policy Makers in Italy, https://wwfeu.awsassets.panda.org/downloads/06062019_wwf_italy_guidebook.pdf
- UNEP (2017). 3/7. Marine litter and microplastics. Available at: <https://wedocs.unep.org/bitstream/handle/20.500.11822/22773/K1800210%20-%20UNEP-EA-3-RES-7%20-%20Advance.pdf?sequence=15&isAllowed=y> [Accessed on November 5, 2020].
- European Commission (2018). A European Strategy for Plastics in a Circular Economy. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN> [Accessed on November 5, 2020].
- Maione, C., Fernandez, G., Vito, D., Marsaglia, L., Cortez, M., Buurstee, C. (2022). Protecting Our Oceans with Citizen Science: El Astillero, Nicaragua. In: Leal Filho, W., Aguilar-Rivera, N., Borsari, B., R. B. de Brito, P., Andrade Guerra, B. (eds) *SDGs in the Americas and Caribbean Region. Implementing the UN Sustainable Development Goals – Regional Perspectives*. Springer, Cham. https://doi.org/10.1007/978-3-030-91188-1_75-1?fbclid=IwAR0bPQ74kYYM5Q212rDvaaBdofkaiTlkdP1-X-j7lQIUxFOhCh8OJ39OAWo#citeas

RECOMMENDED READINGS:

- CIEL (2019). *Plastics & Climate: The hidden costs of a plastic planet*. [Recommended]
- Sharma S, Sharma V and Chatterjee S (2021) *Microplastics in the Mediterranean Sea: Sources, Pollution Intensity, Sea*

Health, and Regulatory Policies. (20 pages)

- M. Cole , P. Lindeque, C. Halsband , T. S. Galloway (2011), Microplastics as contaminants in the marine environment: A review, pp 2588-2597
- Moving away from single-use. Guide for national decision makers to implement the single-use plastics directive.
- J. Wang et al. (2016), The behaviors of microplastics in the marine environment. pp. 7-17
- Bucknall, D. G. (2020). Plastics as a materials system in a circular economy.
- Moving away from single-use. Guide for national decision makers to implement the single-use plastics directive. (56 pages)