Funded by the European Union's Horizon Europe programme under grant agreement No.101060213.

Mediterranean Living Lab

"Tyre Wear Particles: A Source-to-Sea Approach for Prevention and Mitigation Scenarios"

Athens, 19-20 November 2024

Summary Report

Funded by the European Union's Horizon Europe programme under grant agreement No.101060213.

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I. SOS-ZEROPOL 2030 in a nutshell

The Source to Seas Zero Pollution 2030 (SOS-ZEROPOL 2030) project - funded by the European Union's Horizon Europe programme- seeks to develop a holistic zero pollution framework that will guide the EU towards achieving zero pollution in European seas by 2030. The stakeholder-led zero pollution framework will address shortcomings in existing marine pollution management and governance approaches. The project focuses on four priority pollutants: nutrient inputs, contaminants, plastic litter, and underwater noise, alongside two case study pollutants: per- and polyfluoroalkyl substances (PFAS) and tyre wear particles (TWPs). It addresses these issues across three European Regional Seas: the Black Sea, the Mediterranean Sea, and the North-East Atlantic. Read more on SOS-ZEROPOL 2030 at: https://soszeropol2030.eu

The SOS-ZEROPOL 2030 team

II. The LIVING LAB aim and approach

On 19-20th November, 2024, a Living Lab was organized in Athens by the Mediterranean Information Office for Environment, Culture, and Sustainable Development (MIO-ECSDE), in collaboration with partners of the SOS-ZEROPOL2030 project. The primary objective of the Mediterranean Living Lab was to explore the challenges and solutions related to preventing and mitigating emissions of car tyre particles (TWPs) throughout the product chain. This event placed particular emphasis on the eco-design of car tyres and the removal of TWPs at wastewater treatment plants.

TWPs have been recognized as a significant source of microplastics (MPs; defined as particles smaller than 5 mm in at least two dimensions). However, reported particulate emission volumes and environmental TWP concentrations vary widely across different spatial and temporal scales. Car tyres and the associated TWP emissions are known to contain a high concentration and diversity of potentially hazardous chemicals, many of which have been demonstrated to partition or leach into environmental matrices. Nearly 800 additives and non-intentionally added substances (NIAS), collectively referred to as tyre wear chemicals (TWCs), are known to be used in or present in tyres TWPs (see Annex V: Fact sheet Living Lab Athens TWPs, Tyre production and wastewater treatment).

The Mediterranean Living Lab brought together a diverse group of 35 stakeholders, including policymakers, industry representatives, researchers, academics, civil society members, and service providers, from 8 Mediterranean EU Members States (Croatia, Cyprus, France, Greece, Malta, Italy, Slovenia, and Spain) and 6 other EU Member States (Belgium, Bulgaria, Ireland, Germany, Norway, and The Netherlands).

III. Overview of the LIVING LAB

The first day of the Mediterranean Living Lab began with a "setting the scene" session, where participants were introduced to the overall philosophy and approach of the Living Lab, as well as the objectives and main actions of the SOS-ZEROPOL2030 project. This was followed by an overview of the sources, pathways, and impacts of TWPs, along with recent research developments on the topic specific to the Mediterranean region. Additionally, two presentations focused on policy advancements related to microplastics in the EuroMediterranean region. These included discussions on the Barcelona Convention and the Regional Plan for Marine Litter Management in the Mediterranean, as well as relevant policy developments in Europe, particularly the new Ecodesign for Sustainable Products Regulation and the upcoming revision of the Urban Wastewater Treatment Directive.

Participants engaged in discussions on the challenges associated with preventing and mitigating TWPs.

Unfortunately, Dr. Dionysia-Theodora Avgerinopoulou, the Greek Prime Minister's Special Envoy for the Ocean and Chair of the Environment Committee of the Hellenic Parliament, was unable to attend the opening session due to unforeseen last-minute commitments. However, Dr. Avgerinopoulou expressed her strong support for the Living Lab's overarching objectives and reaffirmed her dedication to rallying parliamentarians from across the Mediterranean to address the pressing challenge of TWPs.

The rest of the first day of the Living Lab was devoted to two engaging breakout sessions. The first session, focused on understanding stakeholder perspectives on TWPs, aiming to delve into participants' professional roles, interests, and key concerns related to TWPs pollution. It also sought to uncover their personal priorities in addressing this pressing issue. In the second breakout session, participants worked collaboratively to explore and identify the primary challenges associated with preventing and mitigating TWPs. These challenges spanned technical, regulatory, environmental, and social dimensions. The session also emphasized pinpointing the most urgent priorities for action, thereby fostering a shared vision for tackling TWPs pollution.

The second day of the Living Lab began with two interesting case study presentations: one showcasing the TWPs Risk Assessment Tool developed within the framework of SOS-ZEROPOL2030, and the other exploring the potential of harnessing magnetic extraction for the effective removal of TWPs from wastewater.

The rest of the second day of the Living Lab was devoted to two engaging breakout sessions. The first focused on the topic of needs and preconditions for reducing TWPs emissions, where participants collaboratively identified the key resources, tools, or technologies necessary for effective reduction efforts, along with the regulatory, financial, and collaborative conditions required to support large-scale emission reduction initiatives. The second breakout session explored the criteria that should be prioritized when evaluating the effectiveness of TWPs mitigation strategies and how to balance these criteria (e.g., cost, impact, feasibility) when deciding on approaches to reduce TWPs emissions.

Participants engaged in discussions on the needs and preconditions for reducing TWPs emissions (Photo: Th. Vlachogianni).

IV. Results, findings and outcomes of the Mediterranean LIVING LAB

Governance gaps and challenges

The main governance gaps and challenges identified are presented below:

Environmental Challenges related TWPs

- **Persistence of TWPs in the Environment:** TWPs are highly durable and persistent in the environment, remaining in soil, water, and air for extended periods and accumulating in freshwater and marine sediments. Their small size and chemical composition have the potential for negative impacts in multiple ecosystems. Their persistence makes it difficult to mitigate long-term environmental damage once they are released into ecosystems.
- **Challenges in Understanding TWP Transport Mechanisms:** Understanding how TWPs travel through different environmental media, such as air, water, and soil, is essential for predicting

their spread and impact. However, the transport mechanisms of TWPs are still not well understood. These particles can be carried by wind, water runoff, or even through road dust, which complicates efforts to predict which environmental matrices will be most affected. The unpredictability of TWP distribution makes it difficult to assess the full scale of their environmental impact and to design effective mitigations and remediation strategies. Additionally, the interaction of TWPs with other pollutants in the environment may lead to synergistic effects that further exacerbate environmental harm.

- **Environmental Consequences of TWPs Mixtures:** The mixing of tyres from different manufacturers (with different chemical compositions) introduces additional environmental risks. When different tyre brands are used together, variations in chemical additives and materials may result in complex mixtures of TWPs that could have unpredictable environmental consequences. For instance, certain mixtures may contain higher levels of toxic compounds, including heavy metals or microplastics, which can leach into soil and water, posing greater risks to ecosystems.
- **Unclear Differences in TWPs Generation Between Electric and Conventional Vehicles:** There is still a lack of comprehensive research on the differences in TWPs generation between electric vehicles (EVs) and conventional internal combustion engine (ICE) vehicles. While EVs generally produce less air pollution, the difference in their impact on tyre wear is not well understood. Factors such as weight distribution, torque, and tyre longevity may vary between vehicle types, complicating efforts to assess and compare their environmental impact in terms of TWPs generation. This uncertainty makes it challenging to develop targeted strategies for reducing TWPs emissions across different vehicle categories.
- **Impact of Increasing Vehicle Weight (Especially SUVs):** There is still a lack of comprehensive research on the differences in TWPs generation between electric vehicles (EVs) and conventional internal combustion engine (ICE) vehicles. While EVs generally produce less air pollution, the difference in their impact on tyre wear is not well understood. Factors such as weight distribution, torque, and tyre longevity may vary between vehicle types, complicating efforts to assess and compare their environmental impact in terms of TWP generation. This uncertainty makes it challenging to develop targeted strategies for reducing TWP emissions across different vehicle categories.

Technical Challenges related to TWPs

- **Lack of Standardized Testing Methods and Protocols:** A major challenge in managing and mitigating the impact of TWPs is the absence of standardized testing methods and protocols for measuring and assessing the concentration of these particles in complex environmental matrices. Currently, there is no universally accepted approach for evaluating TWP emissions across different regions, industries or environmental matrices. This lack of consistency makes it difficult to compare results from various studies, complicates regulatory frameworks, and hampers the development of universally applicable mitigation strategies. To effectively address the TWP issue, there is a pressing need for standardized testing methods that are recognized both by the research community and industry stakeholders. These testing methods must encompass the full lifecycle of tyre wear, from abrasion on road surfaces to the final environmental impact, ensuring that the data collected is reliable, reproducible, and actionable.
- **Need for Common Standards in Tyre Manufacturing and Road Infrastructure:** The management of tyre abrasion and TWPs emissions requires a coordinated approach that includes common standards across tyre manufacturing, road construction, and infrastructure development. Currently, there is a lack of uniformity in the materials used in both tyres and road surfaces, which can lead to variations in the rate of tyre wear and the quantity of TWPs generated. For example, softer road surfaces may accelerate tyre degradation, while tyre composition, including the use of various synthetic rubber compounds and additives, can influence particle release. Establishing common standards for both tyre and road infrastructure design would help optimize tyre lifespan, reduce emissions, and ensure that both the manufacturing process and the road network are

aligned to minimize environmental impact. It is important to note that tyre formulations need to maintain the functional properties of the product for safety reasons.

- **Challenges in Managing the Impact of Tyre Composition and Usage:** Tyres are composed of a complex mix of materials, including various synthetic rubbers, chemical additives, and reinforcing agents. These materials play a critical role in tyre performance but also affect the chemical composition of the wear particles released into the environment. The challenge lies in managing these chemicals, as many of them are toxic or persistent in the environment, while others may undergo degradation to persistent and toxic degradation products, adding further to the chemical complexity. Furthermore, the use of mixed tyres—through the combination of different brands—adds another layer of complexity. Mixed tyres may contain varying chemical additives, resulting in unpredictable environmental consequences, such as the release of more hazardous substances that can interact.

Regulatory Challenges related to TWPs

- **Difficulty in Adapting to an Evolving Regulatory Landscape:** The tyre industry faces significant challenges in keeping pace with the evolving regulatory landscape concerning TWPs. One of the main obstacles is the absence of consistent, standardized methods for assessing TWP emissions and their environmental impact. As regulations around microplastics and tyre waste become more stringent, the lack of clear and universally accepted testing protocols makes it difficult for industry stakeholders to align their practices with emerging requirements. This creates uncertainty within the industry, as manufacturers struggle to comply with diverse and rapidly changing regulatory frameworks at both national and EU levels. The absence of standardized assessment methods hinders the development of effective and enforceable regulations, making it harder for the industry to implement and demonstrate compliance with evolving environmental standards.

- **Absence of a Common Regulatory Standard for TWPs:** The lack of a unified regulatory framework for tyre wear and TWPs management is a significant barrier to addressing the issue across Europe. Currently, there is no comprehensive, harmonized approach to regulating the generation, measurement, and mitigation of TWPs at the EU level. This fragmentation complicates the enforcement of consistent practices and targets, as member states may adopt their own regulations or implementation methods, leading to disparities in TWPs management. Such regulatory inconsistency also undermines efforts to standardize tyre manufacturing processes and road infrastructure development.

Social Challenges related to TWPs

- **Raising Awareness about the TWPs Issue:** One of the key social challenges in addressing TWPs is raising public awareness about the issue, particularly in distinguishing TWPs from other types of microplastics. While microplastics in general have garnered significant attention in recent years, the specific role of TWPs as a distinct source/form of microplastic pollution remains under-recognized. Many people are unaware of the process of TWP generation and the resulting potential environmental and health impacts of TWPs. This lack of awareness is compounded by the fact that TWPs are often invisible or not easily detectable, making it harder to convey their significance in environmental discussions.

- **Balancing Technical, Regulatory, Environmental, and Social Factors:** Addressing the pollution caused by TWPs requires the integration of technical, regulatory, environmental, and social considerations, which is inherently complex. On the one hand, technical and regulatory measures are needed to reduce TWPs emissions, ensure effective monitoring, and establish standards for tyre manufacturing. On the other hand, social factors such as consumer behaviour, industry practices, and public attitudes also play a crucial role in shaping the effectiveness of these measures.

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Priorities, opportunities and best practices

During the Living Lab, the following considerations regarding priorities, opportunities, and best practices for preventing and effectively mitigating TWPs emissions were put forward, based on the challenges outlined above:

Priorities to effectively addressing TWPs

- **Sustainable Tyre Design:** Promote the development of more sustainable, eco-friendly tyre designs that use fewer hazardous chemicals and materials. Encouraging innovation in tyre manufacturing will help reduce the environmental impact of tyre wear over time.
- **Promoting Sustainable Transport:** Shift emphasis towards more sustainable transportation options, such as rail-based public transport, to reduce reliance on personal vehicles. This can help alleviate the demand for larger, heavier vehicles, which exacerbate TWPs emissions.
- **Raising Awareness:** Increase public understanding of the environmental and health risks posed by TWPs. This includes encouraging responsible driving habits such as moderate acceleration and braking, which can reduce tyre abrasion.
- **Incentivizing Sustainable Behavior:** Encourage behaviors that reduce TWPs generation, such as driving less. However, it is important to recognize that the burden of these behavioral changes should not fall solely on consumers or civil society; industry should also be held accountable for its contribution to the problem.
- **Developing Technological solutions for TWPs mitigation:** To effectively mitigate the environmental impact of TWPs, it is crucial to invest in and develop advanced technologies for wastewater treatment, runoff collection, and particle capture, as well as appropriate waste treatment process for collected material. This should include the enhancement of stormwater management systems to separate TWPs from runoff, as well as the development of particle traps on vehicles and drain grates. Additionally, technological innovations in wastewater treatment plants should be pursued to better capture and treat TWPs before they enter water systems.
- **Funding and Political Support:** It is essential to secure EU funding for research, innovation, and implementation projects focused on addressing TWPs pollution in the Mediterranean and other regions. These funds could support the development of advanced technologies for TWPs detection, monitoring, and mitigation, as well as initiatives aimed at raising public awareness and influencing policy changes. In addition to financial support, political pressure is crucial to ensure that stronger, more effective regulations are introduced to manage TWPs emissions. This includes advocating for the integration of TWPs-related measures into broader environmental policies, such as regulations on vehicle emissions and tyre manufacturing standards. Political backing is also necessary to ensure the enforcement of these regulations, create incentives for industry compliance, and foster international collaboration to address the transboundary nature of TWPs pollution.
- **Political Accountability:** Raise awareness of the TWPs issue among decision-makers, recognizing that political cycles are often short-term. Long-term solutions to TWPs pollution require sustained political will and accountability, even in the face of changing political landscapes.
- **Standardization and Regulation:** To effectively address TWPs, it is essential to establish common standards for the testing, production, and regulation of tyres to ensure consistency in measurement and reduction efforts. These standards should be supported by both industry and regulatory bodies to enable effective monitoring and enforcement. In addition, implementing labelling regulations to inform consumers about key tyre characteristics, such as lifetime and sustainability, will promote informed decision-making. Ensuring strict quality control of tyre products and holding polluters accountable, for example through Extended Producer Responsibility Schemes, is also crucial to reduce the environmental impact of tyres and encourage industry compliance with sustainability goals.

- **Collaboration Across Stakeholders:** Foster collaboration between various stakeholders—including government bodies, industries, civil society, and the informal sector. Engaging all relevant parties is crucial for developing a comprehensive strategy to reduce and mitigate TWPs emissions, ensuring that efforts are coordinated and effective across sectors.

Opportunities and Best Practices to Effectively addressing TWPs

Targeting driving schools with tailored awareness campaigns:

- Develop specific, tailored campaigns within driving schools to foster a "mindful driving" culture. This could include educating drivers about the environmental impact of excessive acceleration, braking, and aggressive driving, all of which contribute to increased tyre wear and TWPs emissions.
- Incorporate eco-driving techniques into driving curricula to reduce tyre abrasion and fuel consumption, ultimately mitigating the impact of tyre wear on the environment.

Incentivizing alternative transportation modes:

- Promote the use of sustainable transportation options such as public transport, cycling, and walking through incentives like subsidies, tax benefits, or reduced fares.
- Encourage urban planning and infrastructure investments that prioritize non-motorized transport, including safe and accessible bike lanes and pedestrian-friendly pathways.

Introducing a "name and shame" or "name and praise" approach to industry accountability:

- Implement a public reporting system where companies that are leading the way in reducing TWPs emissions or developing sustainable tyre technologies are celebrated and recognized.
- Similarly, a "name and shame" approach could be applied to companies with poor environmental records, placing pressure on them to improve their practices. Transparency around corporate sustainability efforts can drive positive change in the tyre industry and hold companies accountable for their environmental impact.

Ensuring mitigation strategies do not cause unintended environmental side effects:

- Develop and implement mitigation strategies for TWPs reduction that are holistically designed to avoid unintended negative environmental consequences. For example, certain technologies or practices meant to capture or reduce TWPs could inadvertently lead to the release of other pollutants, such as microplastics or chemicals.
- Ensure that each mitigation strategy is rigorously tested for side effects in different environmental settings and scales before wide implementation.

Considering local challenges when creating regulations:

- Tailor regulations and mitigation measures to reflect the specific challenges of different regions. For example, areas with poor road infrastructure or a high concentration of heavy vehicles (e.g., trucks, SUVs) may require different approaches to TWPs reduction than regions with well-maintained roads and lighter vehicles.
- Address issues such as road conditions, climate, and urban density when developing regulations to ensure they are both effective and practical.

Criteria for Evaluating the Effectiveness of TWPs Mitigation Strategies

When evaluating strategies for tackling TWPs, several key criteria should be considered to ensure that the chosen approaches are effective, feasible, and sustainable. These criteria serve as a framework for assessing potential mitigation strategies in the context of their environmental, social, and economic impacts.

- **Minimisation of Tyre Wear:** One of the primary goals is to minimize the mass reduction of tyres during their use. This includes focusing on the durability of tyres, aiming for products that abrade less over time. To assess this, standardised tests on tyre performance—such as mileage, lifetime, and tyre composition—are necessary. These standards should be universally applicable but adaptable to local conditions.
- **Localisation of Strategies:** It is crucial that mitigation strategies are tailored to the unique conditions of individual countries, taking into account factors such as climate, road infrastructure, and regional differences. Establishing baselines for environmental concentrations of TWPs and adjusting mitigation efforts accordingly will help address localised challenges.
- **Feasibility:** Feasibility is the most important criterion for selecting effective TWPs reduction strategies. This includes evaluating the technical, social, and economic viability of a strategy. Strategies should be practical, cost-effective, and easy to implement within existing frameworks. The financial cost of implementation, as well as the availability of infrastructure and technologies, should be taken into account.
- **Environmental and Social Impact:** Mitigation strategies should not cause unintended environmental or social side effects. It is crucial that the chosen approaches do not create new pollution or exacerbate other environmental problems. Furthermore, social considerations, such as public acceptance and the impacts on local communities, should be evaluated. Cultural differences and the potential trade-offs of different mitigation strategies must be taken into account to ensure overall societal acceptance.
- **Timeframe:** The time required for implementation and the long-term sustainability of the strategy are also critical factors. Some strategies may deliver short-term results, while others may require years to show significant effects. Evaluating both short-term and long-term impacts will help in making balanced decisions.
- **Cost and Resource Allocation:** The cost of implementing mitigation strategies is a significant factor in their feasibility. Cost-effectiveness must be a key consideration, with an emphasis on balancing financial investments with the expected reduction in TWPs emissions.
- **Technical Innovation:** While technical innovation plays a smaller role in the selection process, it remains an important consideration. Innovations in tyre production, material science, and particle capture technologies may provide long-term solutions for reducing TWPs.
- **Scoring and Decision Support:** Participants suggested the creation of a scoring system or decision support tool that incorporates all these criteria. Such a tool would enable decision-makers at the EU and national levels to prioritize strategies, ensuring that the most effective and appropriate measures are implemented across regions.

V. Concluding remarks and next steps

Addressing the environmental challenges posed by TWPs requires a multifaceted approach that considers governance, technical, regulatory, and social factors. Effective strategies must prioritize sustainable tyre design and particle retention approaches, promote alternative transportation, and foster public awareness while ensuring that mitigation efforts are tailored to local conditions. Standardization in tyre manufacturing, road infrastructure, and testing methods is essential for consistent, impactful action across regions. Additionally, it is crucial to avoid unintended environmental side effects and consider the long-term feasibility of strategies. By integrating these considerations into a comprehensive framework, stakeholders can develop targeted solutions that mitigate TWPs emissions and promote sustainable environmental practices. The results and insights emerging from the first edition of the Mediterranean Living Lab will provide essential input for the development of future scenarios focused on TWPs reduction, drawing on lessons learned across various stakeholder groups and sectors. These insights will be further explored in a subsequent Living Lab edition (to be organized in the first semester of 2025).

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Annex I: The Mediterranean Living Lab Agenda

Day 1 — 19 November 2024

Time	Content
12:00-13:00	Registration & welcoming lunch
13:00-13:45	**Opening & getting to know each other**
	Opening remarks | Ms Anastasia Roniotes, MIO-ECSDE Head Officer
	Opening remarks | Dr. Dionysia-Theodora Avgerinopoulou, Greek Prime Minister's Special Envoy for the Ocean, Chair of the Environment Committee of the Hellenic Parliament
	Brief overview of the Living Lab workshop | Dr. Thomais Vlachogianni, MIO-ECSDE
	SOS ZEROPOL2030 in a nutshell | Ms Kathrin Kopke, UCC
	Icebreaker
13:45-14:30	**Session 1: Setting the scene**
	Sources, pathways and impacts of TWPs | Dr. Andy Booth, SINTEF Ocean
	Research advances on TWPs in the Mediterranean | Dr. Thomais Vlachogianni, MIO-ECSDE
	Policy advances on microplastics in the Mediterranean | UNEP/MAP Representative
	Overview of TWPs and policy developments in Europe | Ms Linda Del Savio, RIFS
14:30-15:45	**Session 2: Understanding stakeholder relation to TWPs**
	Work in groups
	Comfort break
15:45-17:15	**Session 3: Perspectives and priorities in relation to prevention and mitigation of TWPs**
	Work in groups
	Conclusions & wrap up of day 1
19:00	Networking dinner

Day 2 — 20 November 2024

Time	Content
09:45-10:00	Arrival & coffee/tea
10:00-10:30	**Opening & case studies on TWPs**
	The SOS-ZEROPOL2030 TWPs Risk Assessment Tool in a nutshell | Dr. Andy Booth, SINTEF Ocean & Dr. Thomas Maes, GRID-Arendal
	Harnessing Magnetic Extraction for Effective Removal of TWPs | Dr. Andrej Krzan, Institute of Chemistry, Slovenia
10:30-11:45	**Session 4: Needs and preconditions for TWPs emissions reduction**
	Work in groups
	Comfort break
11:45-13:00	**Session 5: Exploring criteria**
	Work in groups
	Conclusions & wrap up of day 2
13:00-14:00	Lunch

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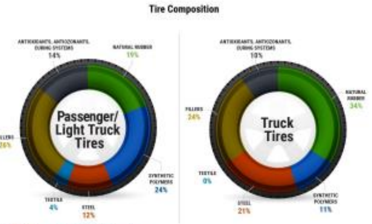
Annex II: The Mediterranean Living Lab factsheet

TWP emissions, transport, effects and mitigation

What are tyres made of?

Vehicle tyres are more than just rubber. In fact, natural rubber accounts for just 19% of a car tyre, with synthetic polymers accounting for 24%, fillers for 26% and additive chemicals 14%. Tyres are therefore a complex mixture of materials and chemicals.



https://www.ustires.org/tires-101

What are tyre wear particles (TWPs)?

TWPs are tiny fragments that are released from tyres as they wear down and have been recognized as a significant source of microplastics, small plastic particles less than 5 mm in size. The amount of TWPs released and their concentration in the environment are highly variable, both spatially and temporally.

https://www.tyroola.com.au/guides/what-are-bald-tyres/

What are tyre wear chemicals (TWCs)?

Vehicle tyres and the emitted TWPs are known to contain a high level and diversity of potentially hazardous chemicals, many of which have been shown to partition or leach into environmental matrices. These are called tyre wear chemicals (TWCs), with nearly 800 additives and non-intentionally added substances (NIAS) known to be used or present in tyres and TWPs.

TWPs and TWCs emissions

TWPs are primarily produced through the friction and wear of tyres upon driving vehicles, meaning that urban, highway and rural roads are the main point sources of TWP emissions, with a direct link between increasing traffic volumes and higher TWP emissions. Heavier vehicles emit more particles by distance travelled, while braking, accelerating and turning further increase emissions. Emissions per km travelled are largest in urban areas (due to increased braking, accelerating and turning), followed by highways and rural areas.

TWPs and TWCs transport and accumulation

Roadside soil receives 45-80% of TWPs and surface waters receive 6-26%, while the smaller TWPs can remain airborne for long periods. TWPs and low mobility TWCs will accumulate in marine sediments, while smaller TWPs and mobile TWCs may be transported away from deposition sites. Estuaries and coastal zones are the primary accumulation zones, especially those closest to urban areas that act as a point source of TWPs.

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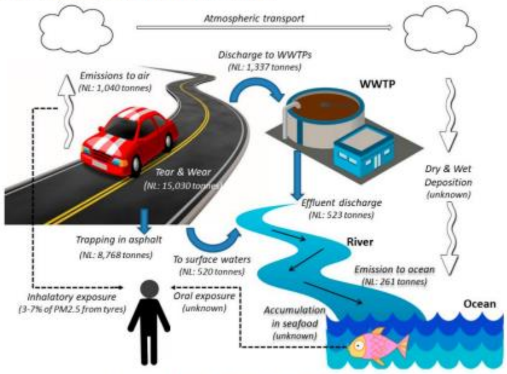
TWPs, TWCs and TWLs environmental effects

Most available research looks at the toxicity of individual TWCs and their leachates (TWLs), rather than that of the TWPs themselves. We lack sufficient data about effects of TWPs on the marine environment to be able to do a complete risk assessment. From a meta-analysis on microplastic particles, Everaert et al., derived a safe water concentration of 6650 particles m^{-3} below which adverse effects are unlikely.

The available evidence strongly suggests that it is the TWCs and their associated TWLs that are the drivers of TWP toxicity to marine organisms. Toxicity identification evaluation (TIE) of leachates, suggest zinc (Zn) as a key toxicant in the inorganic fraction, and a wide range of chemicals as hazard-driving substances in the organic fraction. Variation in the toxicity of TWLs between different tyres has been demonstrated, but there is insufficient evidence to identify the chemicals responsible for the observed variation in toxicity. Hazard assessment could be conducted for a limited (~10) number of TWCs. However, many TWCs have other sources, making it difficult to attribute specific TWC concentrations in environmental samples. As a result, they cannot be reliably used in risk assessments. Despite the scarcity of environmental concentration and effect data for TWCs and TWLs, we expect adverse ecological effects to occur in the marine environment.



Reproduced from Kole et al. 2017: https://doi.org/10.3390/ijerph14101265

TWPs in the Mediterranean Sea

TWP & TWC concentrations in the Mediterranean

In the absence of an empirical European wide exposure dataset, we have created an **exposure model** based on TWPs emission per capita. The exposure model estimates the number of TWPs emitted via natural freshwater systems (rivers, river deltas) into the European regional seas. A population-based model was used to estimate low, medium and high TWPs production/emission scenarios for countries bordering the Mediterranean Sea. For each TWPs emission/production level, three additional emission scenarios (low, medium and high) were modelled for the release of TWPs into surface waters.

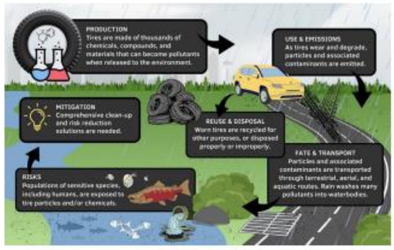
Top 20 catchment areas discharging TWP concentrations within European Seas

Under the low, medium and high emission scenarios, the Mediterranean Sea exhibited annual TWPs emission values of 1.2 trillion particles per year, higher than for other European regional seas. Similarly, the Mediterranean Sea exhibited the highest TWP release concentrations to marine waters. The results indicated emissions to the Mediterranean were highest from North African countries. However, it is important to note that the higher concentrations are strongly influenced by lower levels of rainfall in the Mediterranean Sea than in the other regional seas. Furthermore, the model only estimates emissions and not actual TWP concentrations in marine water or marine sediments, where accumulation of TWPs is likely to occur.

This factsheet is produced from information contained in: Booth, A.M., Sørensen, L., Maes, T., Hansen, B.H., Nepstad, R., Ruhl, R., Fylakis, G., Blaauw, R., Thoden van Velzen, U., Igartua, A., van Hulst, F., Del Savio, L., Cowan, E., van Leeuwen, J., Vlachogianni, Th. (2024). SOS-ZEROPOL2030 Deliverable D4.1 'Integrated Case Study Pollutant Assessment (Part B): Tyre Wear Particles (TWPs)'.

Tyre value chain and stakeholders

While TWP emissions happen primarily during the use stage, there are design and end-of-life criteria that influence the composition and behaviour of the tyres. Along the value chain, wide-ranging stakeholders are involved covering road infrastructure, mobility policies, labelling, recycling of tyres in cement and rubber infills, and energy recovery in coal plants and cement kilns.



New EU eco-design regulation

The Ecodesign for Sustainable Products Regulation (ESPR), replacing the Ecodesign Directive, establishes a comprehensive framework for setting ecodesign requirements, across specific product groups. These requirements include aspects such as energy use and efficiency, durability, and reliability (see figure) The ESPR first working plan will cover energy-related products, including tyres.

Reproduced from :
https://commission.europa.eu/document/download/c5db3b9e-23ae-42c8-a50a-b549f20a377d_en?filename=2024_05_22_EC%20Presentation%20ESPR%20Webinar_final.pdf

Upcoming revision of the EU UWWT Directive

The proposed revision of the Urban Wastewater Treatment Directive includes new measures to tackle microplastics, such as advanced wastewater treatment technologies and improved monitoring of microplastic levels. Additionally, an Extended Producer Responsibility scheme would require manufacturers of microplastic-contributing products, like textiles and tyres, to help fund these wastewater treatment upgrades.

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Annex III: The Living Lab participants

Organization/institution	Country
European Tyre & Rubber Manufacturers Association (ETRMA)	Belgium
Black Sea NGO Network	*Bulgaria*
Institute of Fisheries and Oceanography (IOR)	Croatia
ISOTECH/AKTI	Cyprus
French National Centre for Scientific Research (CEDRE)	France
Research Institute for Sustainability (RIFS)	*Germany*
United Nations Environment Programme/Mediterranean Action Plan (UNEP/MAP)	Greece
Municipal Water and Sewerage Company of Patras (DEYAP)	Greece
Water Supply & Sewage Company of Athens (EYDAP)	Greece
Hellenic Marine Research Centre (HCMR)	Greece
MEDASSET	Greece
Municipality of Amaroussion	Greece
Region of Attica/Water Resources Management Unit	Greece
University of Patras, Chemistry Dpt	Greece
Mediterranean Information Office for Environment Culture and Sustainable Development (MIO-ECSDE)	*Greece*
University College Cork (UCC)	*Ireland*
Italian Institute for Environmental Protection and Research (ISPRA)	Italy
Ministry for Environment, Energy and Enterprise	Malta
SINTEF Ocean	*Norway*
Institute of Chemistry of the Republic of Slovenia	Slovenia
MEDWAVES (former SCP/RAC)	Spain
Wageningen University	*The Netherlands*
Wageningen University & Research	*The Netherlands*

The SOS-ZEROPOL2030 project partner organizations/institutions are listed in italics.

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