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# REDUCTION OF OPEN PIT AND FIELD FIRES IMPACT ON AIR POLLUTION

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**Abstract.** Selecting the most effective policy, its implementation, quantifying its effects and reviewing its Sustainability should be the goal of any environmental study. The purpose of this research is to see the effects of restrictive measures taken by Local and Governmental entities in Republic of North Macedonia, to reduce open pit and field fires. The reduction of these types of Fires has direct impact in decarbonization, depollution, circular economy-waste management, biodiversity and sustainable food systems including spatial planning and rural areas. in the master thesis environmental protection (green) initiatives, impact on Republic of North Macedonia economy, the reduction of open pit fires was identified as the most effective initiative in the short run with immediate and long term effects on citizens health, standard and environment.

***Keywords:*** *Policy, implementation, environment, circular economy, sustainability.*

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## 1. Introduction

One of the key intentions with this study is to try and estimate the impact and causality of Landfill Fires with the emission of PM.2.5 pollution. This type of pollution seems to have the most severe impact on populations health which impacts their wellbeing and from social and economical perspective. When reviewing North Macedonia environmental protection strategy and agenda we were able to focus on the most immediate factor that can significantly reduce pollution and provide immediate and best economic and social outputs.

As we can see there is a multitude initiatives taken by the Government with its Environmental Strategy, but we must take in to account only the ones that are being implemented and the ones that are planed that provide maximum benefits return from each perspective or better defined as fully sustainable projects. However in the Ministry Of Environment and Spatial Planning of Republic of North Macedonia, the annual reports for air quality do not identify the open pit/landfill fires as contributors to the PM2.5 pollution, which I believe is a significant contributor to the bad Air quality in Skopje, Ohrid, Tetovo and country wide since there are documented areas of illegal landfills that citizens keep reporting and we were able to document in vicinity of Skopje region. This pollution would be significantly reduced or brought to zero with consideration of sustainable waste management. Which is at its inception in our Country. Therefore the immediate need to raise attention to stop landfill burning.

## 2. Literature Review

Green economy represents one of the key aspect of most economies in the new century. David W. Pearce, a prominent British environmental economist, introduced the concept of a "green economy" in his 1989 publication, *Blueprint for a Green Economy*. He advocated for sustainable economic progress that respects the boundaries of the natural environment and human well-being. Pearce warned that unchecked economic growth, disregarding ecological impacts, could precipitate environmental crises and socioeconomic decline (Pearce *et al*., 2013). The green economy represents a model of sustainable development that harmonizes ecological and economic objectives, fostering energy efficiency, structural economic adjustments and stable growth. However, the enthusiastic adoption of green economy principles into economic agendas has sometimes led to an overly optimistic blend of green initiatives with free market and growth-driven policies. Green Economy is depended from green finances also! Empirical studies generally confirm a positive, though sometimes complex, relationship between green finance and the green economy. For instance, Falcone (2020) highlighted the critical role of green finance in advancing the green economy, a finding echoed by Iraldo et al. (2011). Similarly, Yang et al. (2022) demonstrated a positive correlation between green finance and the green economy in G7 nations. The "finance-real economy-environment nexus" serves as a key theoretical framework to understand the interplay between green finance and the green economy (Madaleno *et al*., 2022). This model posits that green finance incentivizes businesses to embrace sustainable practices, thereby supporting environmental conservation and sustainable development. By redirecting capital from environmentally damaging activities to sustainable investments, green finance mitigates harmful impacts (Bhattacharyya, 2022). Meanwhile, the real economy influences the environment through its production and consumption patterns, which often generate negative externalities. Green finance helps internalize these externalities, promoting sustainable economic growth (Saha *et al*., 2022).

This segment of environmental impact also can be viewed from the sustainability point of view while analyzing the macro sustainment pillars of: environmental, social and economic impact.

- Economic sustainability entails evaluating the environmental impact of economic activity and devising sustainability goals to create a more livable future;
- Economic sustainability is a broad set of decision-making principles and business practices aimed at achieving economic growth without engaging in the harmful environmental trade-offs that historically accompany growth (masterclass);
- Usually, sustainable development creates operational systems that consume natural capital (also known as natural resources) slowly enough that future generations can also use those resources (masterclass);
- Social sustainability - when people feel part of the development process and believe they and their descendants will benefit from it - is fundamental to addressing today's development challenges; where the social component is the counterpart of environmental and economic sustainability (World Bank).

Building on decades of engagement on social development, the World Bank's focus on social sustainability encompasses inclusion, resilience, cohesion and process legitimacy (World Bank). Global development is at an important crossroads. Despite remarkable gains over the last several decades, a growing number of challenges threaten to reverse development gains and jeopardize the prospects for continued progress (World

Bank). These include rising inequality and erosion of trust within societies to climate change, pandemics and increasing conflict across the globe (World Bank). Environmental sustainability is the responsibility to conserve natural resources and protect global ecosystems to support health and wellbeing, now and in the future (Sphera).

Human wellbeing is in direct correlation with state of the environment. Around the world, 24% of deaths can be traced back to avoidable environmental factors, according to the World Health Organization. People need clean air to breathe, fresh water to drink and places to live that are free of toxic substances and hazards. While experiencing the long-term consequences of intensive industrial growth and energy use, we must act to reverse these effects and prevent further damage, making sure we have healthy places to live for generations to come. This means that businesses should commit to environmentally sustainable practices to help build thriving communities and secure future growth potential.

## 3. Characteristics - Waste Management

Regulating and setting proper regional waste distribution centres, all five of them in north Macedonia would have significant impact on air quality and underground water streams. Reason would be no more illegal dump sites, no more pit fires and all of these regional waste sites would contain contaminant leakage underground. In later phases composting can be promoted, gas (methane) emissions can be captured for power production and reduction of Green House Gases GHG etc.


**Figure 1. Source:** https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en

All of these processes introduction represent the Inception of Circular economy through enabling an efficient recycling system. The precursor of a sustained waste recycling system is waste sorting, there is a lack of policy and culture for waste assortment now a days. The best and most positive examples of waste recycling in our country is steel materials purchase cardboard and plastic bottles, however these waste materials are highly incentivized with its purchase price, otherwise there is no legal nor cultural incentive to sort waste. Proceeding with analysis we can see the Waste treatment steps and process of enabling a sustainable and circular economy based system.

**Figure 2.** North Eastern Skopje, Orlanc/Nikushtak (Lipkovo Municipality Dump Site) August 2024

**Figure 3.** East Skopje Haracina Municipality Dump site, Sep 2024

**Figure 4.** Skopje North side Vizbegovo Illegal Dump Site, Sep 2024

*Health Effects of Short-term Exposures* (https://www.stateofglobalair.org/)

In the short term, exposure to air pollution (represented as daily air pollution concentrations or air quality index values) can impact an individual's health. During certain high-pollution days (or episodes), the effects can be more severe. Exposures over a few hours to a few days can contribute to ear, nose and throat irritation (SOGA).

*Health Effects of Long-term Exposures (SOGA)* (https://www.stateofglobalair.org/)

From a public health standpoint, some of the most substantial effects of air pollution come from long-term exposures to air pollutants. Finally, a growing number of studies suggest that air pollution can contribute to several other diseases including brain health outcomes (e.g., neurological effects in childhood and adolescence and neurodegenerative disease in adulthood) (SOGA). Given these effects, exposure to air pollution can also reduce life expectancy (i.e., the number of years that a person might expect to live) (https://www.stateofglobalair.org/) (SOGA).

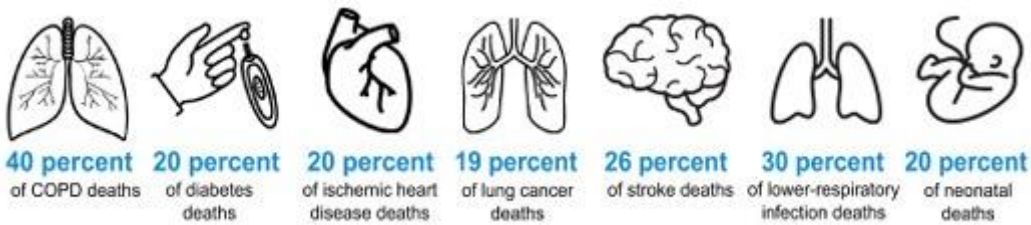


**Figure 5.** Percentage of Global Deaths (by Cause) Attributed to Air Pollution in 2019
**Source:** https://www.stateofglobalair.org

## Reduction of Open Pit and Field Fires impact on Air Pollution

### *Sustainability-Profit of Waste Treatment/Management*

Even though waste treatment touches multiple green initiatives that can be considered and analysed we are going to focus on primary impact of decarbonisation and release of pollutants from burnt garbage. In accordance with EU assessments one (1) tonne of burnt garbage releases 1.1 tonne[1] of $CO_2$. Let's proceed with calculations of just one example of how much negative contribution to $CO_2$ emissions have the illegal unregulated dump sites and there are hundreds in North Macedonia small medium and large. We are going to review the impact of illegal municipal dumpsite of Lipkovo. In accordance with latest census the Municipality of Lipkovo has 21560 residents. This number of residents does not include peak times and considerations for about 5000 to 10000 residents that travel back and forth or return for the holidays[2].

So, if we take in consideration the amount of waste that one citizen creates during a year (503 kg/person) and multiply it with number of people in the municipality of Lipkovo (21560) we can see that Lipkovo residents produce 10,844,680 kg of garbage, or expressed in tonnes 10,884 tonnes having inconsideration the wait of the contributing citizens is at minimum without the diaspora impact we can safely assume that this amount of garbage is annually burnt. This depositing cite is on fire day and night. Under the assumption that 10,884 tonnes of garbage are burnt on this illegal dump site we can safely assume that this site produces 10,884*1.1= 11,900 tonnes of $CO_2$. Also due to the mixture of garbage we will use the assumption that with the production of one tonne of $CO_2$ from Coal there is a release of half a kg of PM2.5 matter, then we can see that 11,900t*0.5kg=5950 Kg of PM2.5 pollution. If we monetize the amount of 11,900 tonnes of $CO_2$ released via the June $CO_2$ storage cost of 74 Euro per tonne, we can see that we have lost a financial opportunity of 880,600 Euro's. If we assume that the whole quantity of collected waste in 2023, is 878,303 tonnes and we can see and understand that between 30% and 40% ends up burnt than we can calculate that 351,321 tonnes (40%) of garbage is burnt on national level which would release 386,453 tonnes of $CO_2$. In monetary value the release $CO_2$ on national level 386,453*74 Euro per tonne storage and exchange price in June would represent a lost opportunity of 28,5 Mill Eur.

The amount of PM2.5 would be estimated at 386,453 tonnes* 0.5kg=193,226 kg PM2.5

### *Sustainability-People of Waste Treatment/Management*

The main point of each green initiative is to bring economic, social and environmental benefits the social or people benefit of green initiatives are realized through improved income, improved lifestyle and health. If we look at the EU waste Directive targets (https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en) we can see that in 2024 we are at 0% of waste selection, maybe 20% of waste recycling organized through commercial entities, mainly paper, plastics and metals. While EU strives to create a cyclic economy in the waste management domain our country is in its inception phase of regulating disposal, we are defining it as an inception stage due to the fact that even the regulated dump sites in western Polog region and North East regions don't have proper dump and distribution canters, the collection

[1] https://zerowasteeurope.eu/2020/09/no-time-to-waste-incineration-and-waste-to-energy/
[2] https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.stat.gov.mk%2Fxls%2F2022%2F2.1.22.10-mk-en.xlsx&wdOrigin=BROWSELINK

and selection of recycling materials has not even started, aside from commercial entities interested and specialized in recycling of paper, metal, glass and electronic waste. With above analysis in mind and current status of waste moment in our country the main focus should be in prompt, immediate and emergent way to regulate waste disposal sites with interim solutions total firefighting control and fire monitoring in all legal and illegal dump sites.

Garbage fires seems to be the main contributors of air pollutants in North Macedonia with the accompanied release of dioxin, benzene and other harmful molecules in the air. Seeing the PM 2.5 amounts released from open pit fires 193,226 kg/PM2.5 on annual basis, it annuls the positive effect that the photo voltaic power production had via reduction of coal power production in 2023, in the amount of 116,988 kg/PM2.5. If the national and EU target is 11 micrograms of PM2.5 in $m^3$ with the intent of extending population life span through health improvement. Then waste management, better yet waste disposal and fire control becomes the foremost green initiative. North Macedonia PM2.5 exposure in 2023 was 22 micrograms per $m^3$.

**Figure 6.** North Eastern Skopje, Orlanc/Nikushtak (Lipkovo Municipality Dump Site) Aug 2024

***Sustainability - Planet of Waste Treatment/Management***

Waste treatment initiative besides decarbonisation that can be achieved through proper regulation and fire control, besides impacting air quality it would also stop leakage of waste emissions in the air and soil and underground water sources. The biodiversity that is suffering from enormous pollution of rivers, air and soil cannot be replenished without Improvement of waste management disposal.

***EU waste management targets*** (https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en):

- by 2020, the preparing for re-use and the recycling of waste materials (EC);
- by 2020, the preparing for recycling, re-use and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste shall be increased to a minimum of 70 % by weight (EC);
- by 2025, the preparing for re-use and the recycling of minimum 55 %, 60% and 65% by weight by 2025, 2030 and 2035 of municipal waste shall be increased to a respectively (EC).

**Table 1.**

| Т-01: Создаден комунален отпад во Република Северна Македонија и годишно количество на комунален отпад по жител, 2023 година | | |
|---|---|---|
| **T-01: Generated municipal waste in the Republic of North Macedonia and annual amount of municipal waste per person, 2023** | | |
| Референтен период<br>Reference period | Создаден комунален отпад[1)]<br>(во тони)<br>Generated municipal waste<br>(in tonnes) | Годишно количество на комунален отпад по жител[1)]<br>(во кг)<br>Annual amount of municipal waste per person<br>(in kg) |
| 2019 | 915 943 | 456 |
| 2020 | 913 033 | 452 |
| 2021 | 896 066 | 452 |
| 2022 | 856 766 | 467 |
| 2023 | 878 303 | 503 |
| [1)] Податоците се проценети врз основа на бројот на резидентното население според Проценте на населението, освен за 2021 година, кога проценката е извршена според податоците од Пописот на населението, домаќинствата и становите, 2021. | | |
| [1)] Data are estimated based on the number of resident population according to the Estimations of the Population, except for 2021 when the estimation is made according to the Census of Population, Households and Dwellings, 2021 | | |

## 4. Research Methodology

The significance of multiple waste fires as a local or regional source of air pollution has not been extensively discussed. Wiedinmyer et al. (2014) estimated the emission of particulate matter (PM), toxic compounds and trace gases from open waste burning on a global scale. However the focus of the research is with local focus in North Macedonia. Waste fires significantly impact Air Quality in North Macedonia. North Macedonia's cities end up with lowest quality of air in Europe and in the world. The 3P sustainability methodology of research was chosen since I believe that it best expresses the benefits of total waste management and the benefits that can be quantified from all three points of analysis; Environment, Economy and Society.

Besides the measurement of approximate pollution from garbage burning while researching and calculating local to national level garbage burning contributions to Air Pollution, we also tried to estimate the approximate participation of landfill fires polluting PM2.5 emission on national level. When Looking at Figure 1, we can notice that under Other Pollutants; nowhere in the description pollution from burning waste is captured.

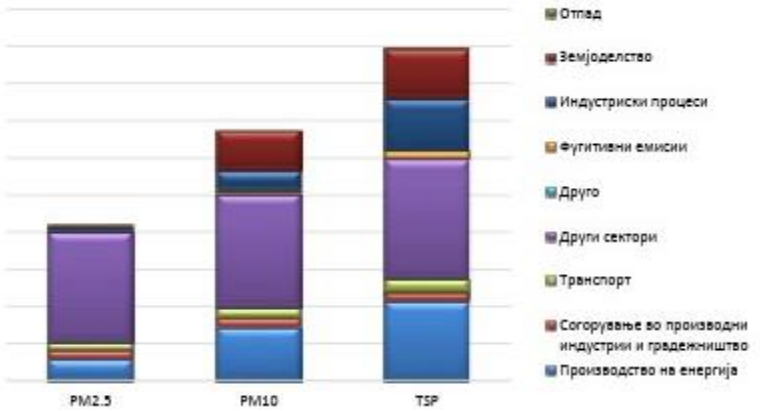


**Figure 1.**

**Source:** https://www.moepp.gov.mk/sites/default/files/alfa/doc/izvestai/indikatori/2024/2_vozduh_2024.pdf

## 5. Research Results

Depending on Governments approach, if it strongly engaged in establishing full waste treatment system in the country at different stages in time and in process the Economy benefits would be immediate with progressive growth in following order:

Immediate policy support and implementation to stop dumpsite fires, this will bring immediate results, because the resources in policing and firefighting are there:

- In monetary value the released $CO_2$ from waste fires on national level is 386,453t *74 Euro per tonne storage and exchange price in June would represent a lost opportunity of 28,5 Mill Eur (June 2024 $CO_2$/tonne capture price EU Exchange).
- The amount of PM2.5 would be estimated at 386,453 tonnes* 0.5kg=193,226 kg PM2.5

*Waste management is inadequate, with municipal waste being disposed of in 54 non-compliant municipal landfills (WB). Power depends upon the burning of lignite in outdated generators producing 70 per cent $CO_2$ emissions* (*UNDP). Air pollution is responsible for about 2,600 deaths annually, with economic losses estimated at 3.2*[3] *per cent of GDP*[4] *(UNDP).*

While it is hard to collect data on main polluters with PM 2.5, we know that the PM 2.5 pollution is one of the main factors impacting Human life. If we intend to improve our Nation's health we must focus reducing open pit fires and reaching the EU standard of 11 micrograms of PM 2.5 in cubic meter of air. This will halve the number of illnesses incidence in our population and will result in significant health funds savings. Healthy workforce follows up with healthy production.

If we take in consideration that one quarter (25%) of this pollution is coming from opened pit fires and from photos below we conclude that the situation got worse since 2020 than 3.2% of 15.9 Billion (GDP 2024) would be around 500 Million USD or 150 Million USD just from the opened pit fires.

Skopje valley is surrounded by these illegal dump sites it even got one at its hart the Vardarishte one, located in the Municipality of Gazi Baba where the highest concentration of pollution is usually located.

## 6. Discussion and Conclusion

While looking at benefits of all green initiatives, we have foregone the benefit of circular economy. There is a chain of processes where circular economy enables economic growth and sustainable development.

Most reviewed policies and green initiatives are labelled as decarbonization initiatives; hence the primary benefit and goal are reduction of greenhouse gasses, notwithstanding this benefit and goal, there is a whole gamma of benefits and goals that can be achieved during different stages of building a sustainable waste treatment system in our country.

As mentioned in analysis above our country's waste treatment system, is at its inception, and for each implemented phase, there are significant benefits.

[3]World Bank systematic country diagnostic, 174-176. Renewable energy comprised 7 per cent of power by 2016

[4]Executive Board of the United Nations Development Programme, the United Nations Population Fund and the United Nations Office for Project Services-Country programme document for the Republic of North Macedonia (2021–2025), 1 December 2020(Page 4)

In accordance with a recent study of SEEU professors (Bytyqi *et al*., 2024), they were able to identify two common determinants of Economic growth and Environmental sustainability. The Determinants of Environmental Taxes and Recycling. Both determinants have positive impact to Economic growth in the long run, while Environmental Taxes seem to have negative impact on Environmental Sustainability whereas recycling proves to be main contributor to Environmental sustainability.

I believe that one of the main contributing factors for the negative impact green taxes have in the Environmental Sustainability, at least it can be proven from North Macedonia 40% (Figure 2) realisation of collected green taxes. This thesis supports the Professors findings, under the conclusion that a huge amount of purposefully collected taxes, about 60% of it or about 152 Mil Eur in 2021 probably ended up spent in different purposes than Environmental. Part of these funds should have been allocated to Waste Management programs and creation of Depositing sites where fires would be restricted.

Improvements in waste collection, treatment and Management has a three-prong effect besides de carbonisation it also enables clean soil and water, but what is most significantly it is in direct and very intensive causal relationship with Air Pollution.

Looking at Table 1 above under other pollutants we can certainly incorporate and claim that 50% of that indicated pollution is caused by landfill fires and surely if the Government cared to implement a stop gap measure it would immediately affect the quality of Air by emission reduction for at least 25% to category of "Healthy" Air. This stop gap measure would entail strict prohibition of landfill fires, 24/7 monitoring and quick firefighter interventions to suppress fires. Elimination of open pit fires therefore is considered a crucial initiative in providing sustainable effect to Environment, Society and Economic Growth. Any activity at whatever level of realisation can have immediate effects in our economy being alternate $CO_2$ cost reduction, air and soil pollution etc.

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