Crashes aren't green; saving lives saves the earth too

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Executive Summary

Climate change has a disastrous effect on the environment; it forces humans to change their ways and find more sustainable processes to slow down such effects. Because of global warming, wildfires and flooding events are becoming more frequent and violent every year. In 2021, the Intergovernmental Panel on Climate Change (IPCC) warned that global warming must be limited to 1.5°C to prevent further escalation. Since then, countries and authorities have been putting in place policies and laws to comply with the findings of the report. However, a key part of emissions has been missing from the different policies. For a long time now, vehicle collisions have only ever been looked at from a safety and economic perspective. Nevertheless, crashes are not green, saving lives saves the earth too. This paper looks at the environmental impact of vehicle collisions.

In the UK, the transportation sector was the largest contributor to greenhouse gas (GHG) emissions in 2019, accounting for 27% of total emissions, most notably carbon dioxide (CO2) and nitrous oxides (NOx). The Department for Transport (DfT) and the different local authorities such as Transport for London (TfL) have been acting on reducing those numbers with regulations and policies such as the Ultra-Low Emission Zones (ULEZ) in London.

TRL has begun modelling to quantify the emissions that result from collisions. To begin with, a generic timeline of a crash has been defined. This led us to identify where the different impacts are coming from. Those sources were then divided into three different categories. The first category is 'material – instant' and contains the emissions resulting straight from the collision, such as any spills or leaks that might happen. Then, there is the "human environmental costs" category that explores the effects of the injuries sustained by a person involved in the collision, such as the fuel emissions of the ambulance or the waste produced by the hospital while treating the injuries. This category even includes the possibility of death and its eventual effects. The last category is 'material – prolonged' and covers the effects of the repairs needed for the vehicles or street furniture, as well as towing and scrapping vehicles. Moreover, we took into consideration various conditions/locations and how they would affect the emissions.

The severity of a crash has an important effect on the total emissions. In line with police categorisation, there are four severity levels for a crash, ranging from damage only through to a fatal incident.

We used a literature review to find any studies made on any of the mentioned effects in order to begin creating a complete model that would cover the whole timeline. The model will easily calculate the environmental impact just as previous models have done with the societal costs of collision casualties.

In conclusion, as the world is focusing on reducing the effects of climate change, this paper sheds light on a neglected aspect of vehicle collisions: their environmental impact. The model can show the total emissions resulting from a collision, thus highlighting the importance of mitigating these emissions by making the transport sector even safer. By using this model, local authorities could identify sites where road improvement schemes (to reduce the number or severity of collisions) could reduce the greatest amount of greenhouse gases. Especially as collision monitoring has only previously been used for human, safety and financial costs. The environmental costs of collisions go hand in hand with these and can further help decision making.

1 Introduction

Climate change increases the likelihood of catastrophic events which occur across the world such as frequent wildfires, deadly flooding events, and severe droughts. Due to these catastrophic events, the Intergovernmental Panel on Climate Change (IPCC) was established to advance the knowledge on climate change. In 2021, the IPCC reported that global warming must be limited to 1.5C to prevent further escalation (IPCC, 2021). Since 2011, global GHG emissions which add to climate change have continued to increase reaching current averages of 50 billion tonnes annually being emitted.

The 2021 IPCC report on climate change shows that if the world fails to limit global warming to 1.5C above pre-industrial levels, the floods and fires seen across the globe will become fiercer and more frequent, crops will be more likely to fail, and rising sea levels will drive millions out of their homes and cities. Beyond the 1.5C limit, the risks are greater, as the melting of arctic permafrost would release great amounts of stored greenhouse gases, meaning loss of control over climate resulting in further catastrophic consequences (IPCC, 2021).

In light of this report, the UK Government has thus put a net zero strategy to 'build back greener' and reach net zero carbon emissions by 2050. The strategy sets out policies that cover all sectors based on four key principles aimed at ensuring a swift long-term transition towards 2050: working with the grain of consumer choice, ensuring the biggest polluters pay the most for transition, ensuring that the most vulnerable are protected and working continuously with businesses to deliver cost reduction in low carbon technologies (GOV.uk, 2021). Out of all sectors targeted by the strategy, transport is a key sector.

In fact, in 2019, transport was the largest contributor to GHG emissions. The sector accounted for 27% of total GHG, 122 megatons of CO2 equivalent units (MTCO2e) out of a total of 454.7 MTCO2e. Out of those, 91% came from road transport (111 MTCO2e). Cars and Taxis contributed to 61% (68MTCO2e), HGV 18% and vans 17% (GOV.UK, 2021). The government has created legally binding carbon budgets as well as promising to deliver net-zero by 2050 in all transportation. In November 2020, the government announced a commitment to end the sale of new petrol and diesel vehicles by 2030 (GOV.UK, 2020). Earlier this year, DfT announced a £30 million fund competition for cutting-edge, innovative ideas to decarbonise the country's highways (GOV.UK, 2022). As of 2035, it is estimated that air pollution would cost health and social care £3.5 billion. The annual social cost of urban roads and noise in England is also estimated to be £7 to 10 billion (GOV.UK, 2022).

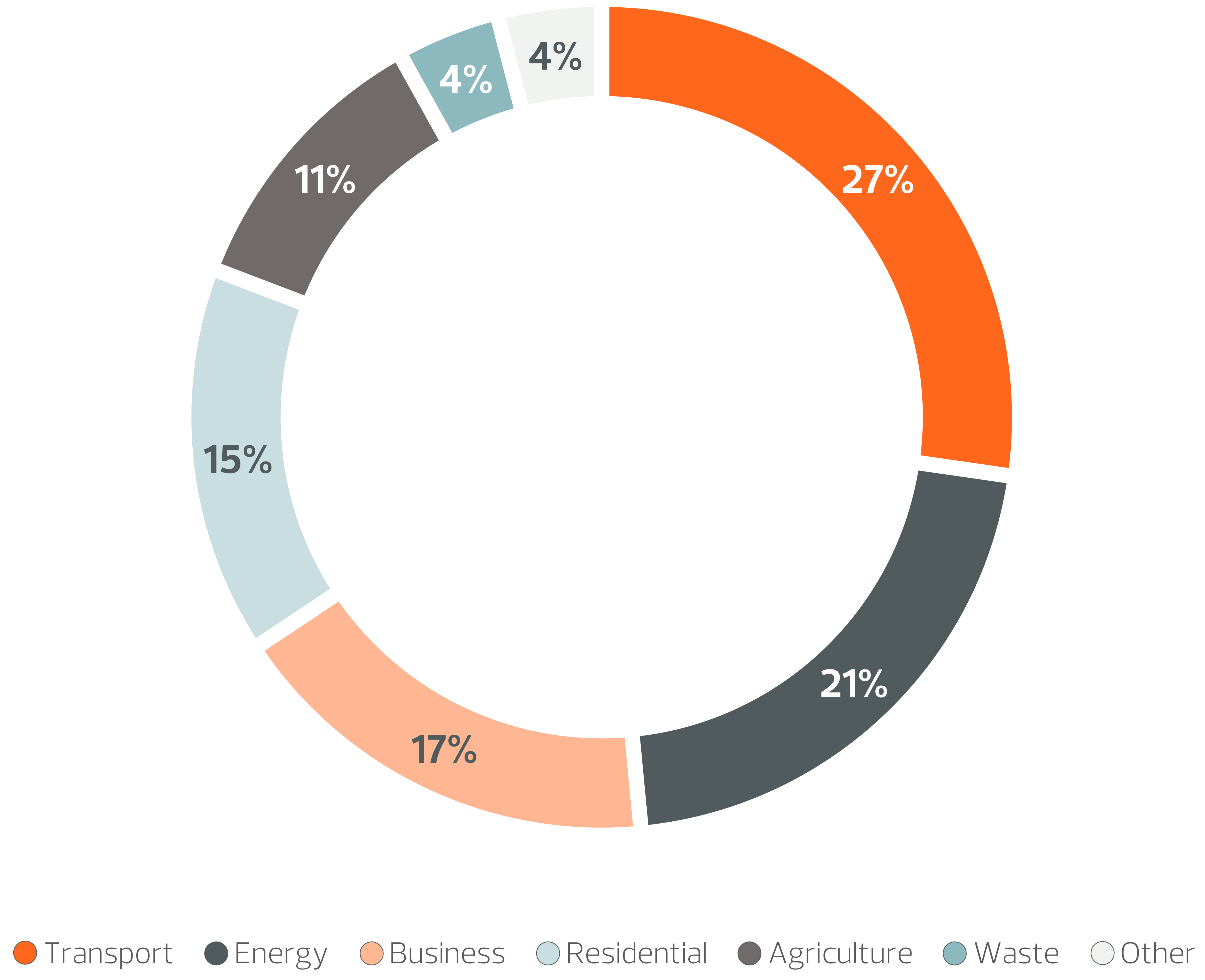

Figure 1: The greenhouse gas emissions by sector (data sourced from: Transport and environment statistics: Autumn 2021, Department for Transport)

The focus on the environmental impact of transportation is at an all-time high. Currently, emissions from vehicles are continuously being captured to understand how they can be reduced to meet targets and policies. The Emissions are typically captured at the roadside and usually do not concern the whole life cycle including what the vehicle externally effects. Policy and regulations are pushing consumers to purchase alternatively fuelled vehicles such an electric or hydrogen fuelled to reduce these roadside emissions. While these vehicles are beneficial to the environment with minimal emissions there is concern over collisions and the pollutants they may release in the advent of a collision. This model will be able to benefit the policy makers to understand the whole lifecycle of a vehicle and how to make their roads and vehicles safer and more environmentally friendly.

For this reason, all aspects of transportation need to be considered to meet these targets and reduce the impact of climate change. Collisions have traditionally been looked at from a safety and economic view. The DfT's Transport Appraisal Guidance (WebTAG) contains collision-related costs and the benefits of avoiding them, as well as costs on different types of injuries. In 2020, there were 11,584 casualties of all injury severities, including 1,460 reported road deaths, (GOV.UK, 2021). The cost to society of just one fatal accident in 2020 resulted in over two million pounds in prevention cost as presented in the RAS60 statistics (GOV.UK, 2020). The cost of a slight accident was substantially lower, but not trivial, costing 24,960 pounds. Prevention costs from reported road accidents totalled to 28.4 billion pounds in 2020 (GOV.UK, 2021). However, the costs of collisions to the U.K taxpayer are believed to be undervalued, by failing to consider the environmental impacts of such collisions, which are still unknown.

All parts of society, including the victims and their loved ones, their employers and taxpayers are affected by collisions in a multitude of ways. Medical care costs are frequently shouldered by the individual through insurance payments and uncovered costs. Costs are carried through society, by the diversion of medical resources away from areas including research and public health requirements. There are also notable costs associated with the loss of productivity experienced by the individual and others when the victim dies or experiences long term injury or disability. The victim and any dependants suffer immediate economic hardship in the wake of the loss of the victim's income, while society supports the victim and/or dependants. All those costs are included in the prevention figures found in the RAS60 statistics except the environmental costs.

Aside from the financial implications, victims suffer from the pain of their injuries, disability, and emotional implications.

This paper aims to shed light on the environmental impacts of collisions and present a tool which can help with identifying the carbon footprint of a collision site.

2 Timeline of a Crash

To understand the environmental impact of a collision even further, we thought of different scenarios. First, the location in which the collision occurs. Car collisions in the United Kingdom occur in a wide variety of locations, from motorways (including A {M} roads) to car parks. As such, for the purpose of this project, we decided to consider the environmental impacts of a variety of both rural (non-built up), and urban (built up) roads. This encompassed: Motorways (including A{M} roads, Urban 'A' roads, Rural 'A' roads and other urban and rural roads). When considering the environmental impacts of both rural and urban roads, it became evident that certain environmental impacts would produce a greater level of CO2e depending on the location and level of traffic flow, i.e., a collision on a motorway will produce more CO2e in congestion emissions than a single urban carriageway. By assessing the environmental impacts of collisions on a variety of roads, we were additionally able to identify the different costs associated with a particular impact on different roads, i.e., repairing an urban motorway would cost a lot more than repairing a single rural carriageway.

We also considered the various types of collisions. To fully understand the environmental impact of a collision, it was vital that we considered a range of crash types. Although we often just describe any car collision as a 'crash,' there are a multitude of types, from head-on-collisions to rollovers. As such for the purpose of this project, we decided to consider the environmental impacts of the following types of car collisions: side-impact, head-on and frontal collisions, rear-end collision, side swipe and single vehicle crashes, with pedestrians, and fixed objects.

To begin with, the different steps involved in the collision should be identified to determine the environmental impact of a collision. An early brainstorming helped us come up with a generic timeline of a collision. As seen in Figure 2, the timeline of a crash is divided into two categories: Impact and post-impact. As soon as the impact happens, particles are released and debris are scattered around the scene: glass shatters, paint flakes and other vehicle components. Straight after the impact (post-impact phase), congestion starts to build up if it is a busy road, and the police rush to the scene. From this point onwards, the footprint is heavily dependent on the severity of the collision. One or more vehicles might require towing away, repairs, or scrapping and replacing. If street furniture or barriers have been damaged, they would require repair too. Then, if people have been injured, a trip to the nearest hospital is needed, where they would be treated accordingly. If their injuries are more serious, then they would have to stay in hospital for longer, and if people died in the collision, funeral services would be required.

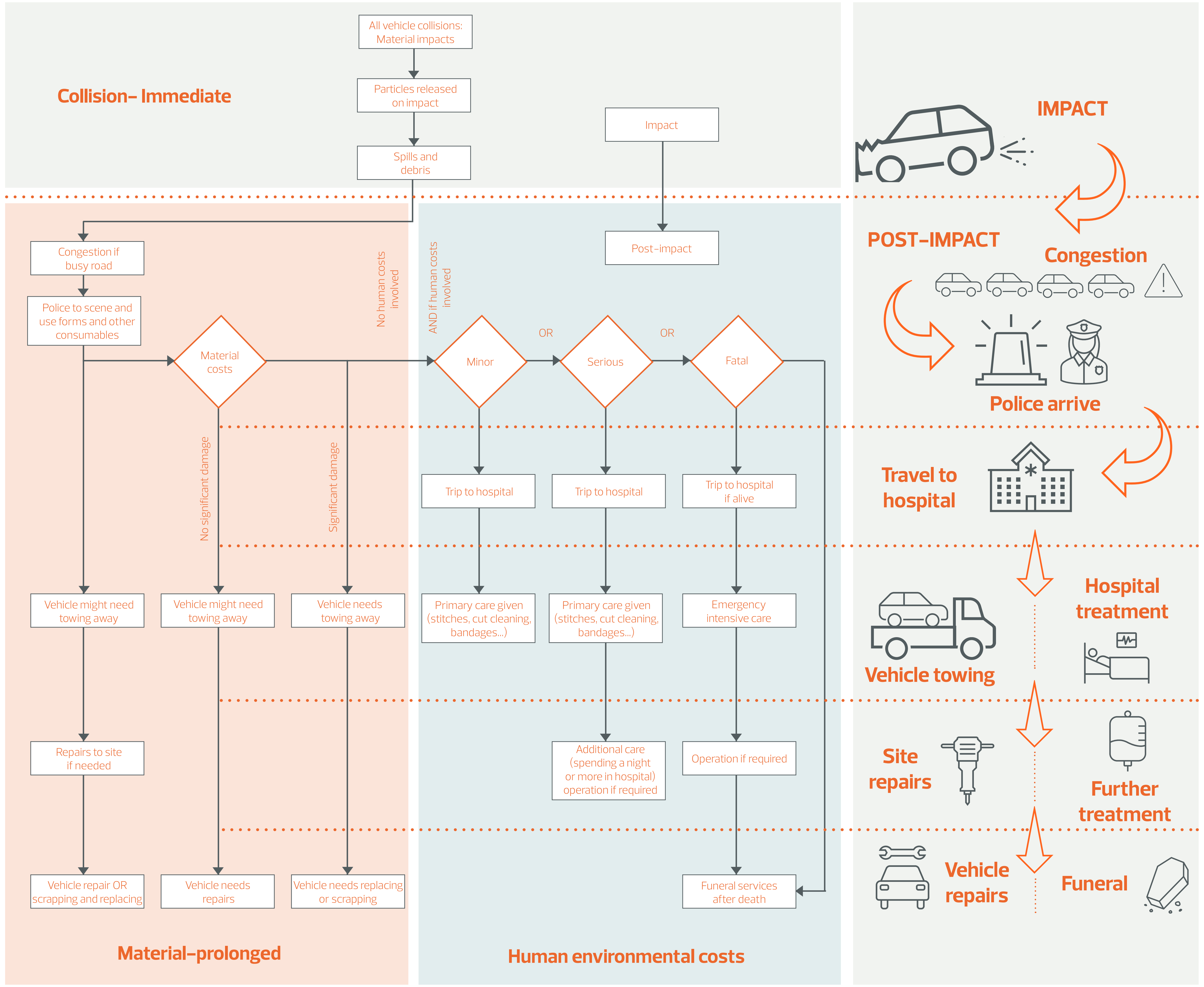

Figure 2: Showing the timeline of a crash split into impact and post-impact as well as collision-immediate, material-prolonged and human environmental costs

3 Environmental impacts

Motor vehicle collisions, commonly result in injury, permanent disability, and/or death. Police categorise collisions based on the severity of the injuries sustained. Collisions are classified as: fatal/likely to prove life-changing, serious injury, minor injury, or non-injury (damage only). A life-changing injury is one that significantly disrupts one's daily activities; examples include paralysis and limb loss. A change or disturbance in a person's capacity to carry out daily activities is required for an injury to be classified as serious; examples include fractures (of any description), internal injury and severe cuts (four stitches or more). Injuries requiring a period of detention in a hospital as an in-patient (staying one or more nights), either immediately or later, are also classified as a serious injury. Any injury that causes just minor disturbance is referred to as a minor injury, i.e., bruises, sprains, and slight cuts, (three stitches or less). Injuries requiring a hospital visit of a matter of hours and not an overnight stay, i.e., slight cuts (requiring 3 or less stitches), are classified as minor. Reportable collisions where no person suffers any injury are classified as damage only collisions.

Severity	Example
Damage only	No injury
Minor	Cuts, bruises, scratches and slight cuts
Serious	Fractures (of any description), and severe cuts (four stitches or more)
Fatal	Cease of life

Table 1: Examples of injuries relating to the police collision severity levels

Hence, while thinking of the environmental impacts, it is important to categorise the collisions as this will lead to a better understanding of the resulting environmental impact. For example, a minor injury may need no further treatment and therefore, have a minimal environmental impact whereas a serious injury would have a higher environmental impact due to the aftercare (treatment, trip to hospital, energy and resources used during hospital stays etc). Throughout this report, we will be classifying collisions as: damage only, minor, serious and fatal.

From the crash timeline and the different severities, we looked at all potential sources of pollution by conducting a brainstorm, in parallel with a related literature review. The brainstorming resulted in three categories that include the different aspects of environmental impacts. The three categories are 'collision-instant,' 'human environmental costs' and 'material-prolonged'. Each category examines different environmental impacts of a collision. The 'collision-immediate' focuses on the environmental impact the collision has straight away on the area where the crash takes place. The 'human-environmental costs' examines the impact of the person, for example the environmental cost of their medical treatment. Finally, the 'material-prolonged' concentrates on the environmental impact of the car from repair activities to scrapping. Altogether these three categories shown below on figure (3), provide an insight to the many environmental impacts caused by a vehicle collision.

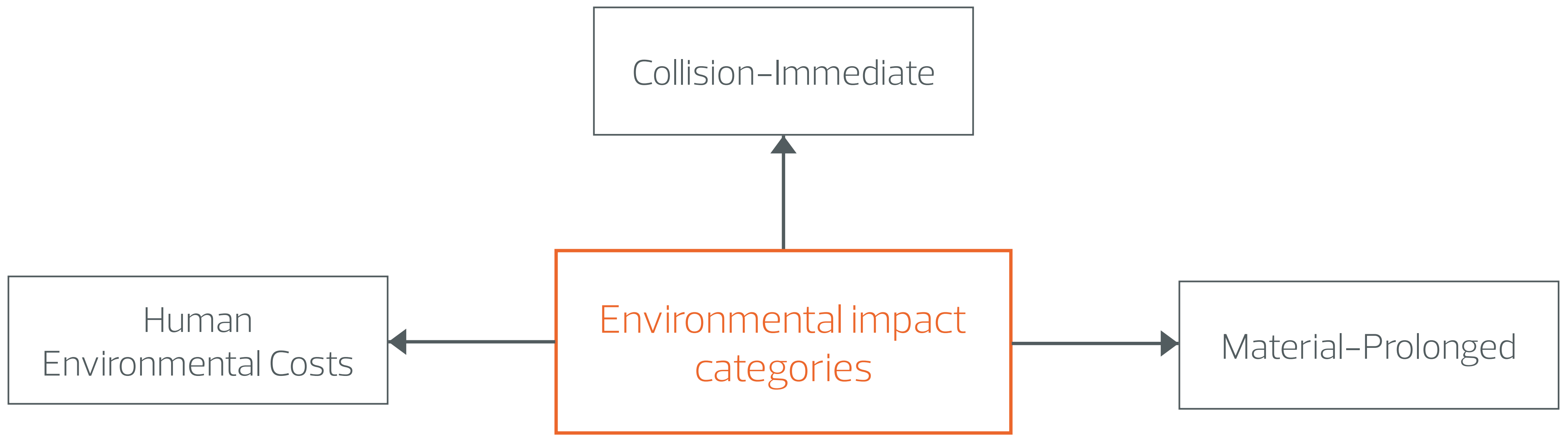

Figure 3: the three main categories of environmental impact

3.1 Collision–Immediate

First, the immediate environmental impacts of a collision were examined to understand what initial environmental impacts are found. This includes the particles released on impact as well as any fires, spills or debris caused. Moreover, the collision would most likely cause congestion that would further increase vehicle emissions. Finally, police coming onto the scene would also cause additional emissions and consume some expendables such as tape and different paper forms or logbooks.

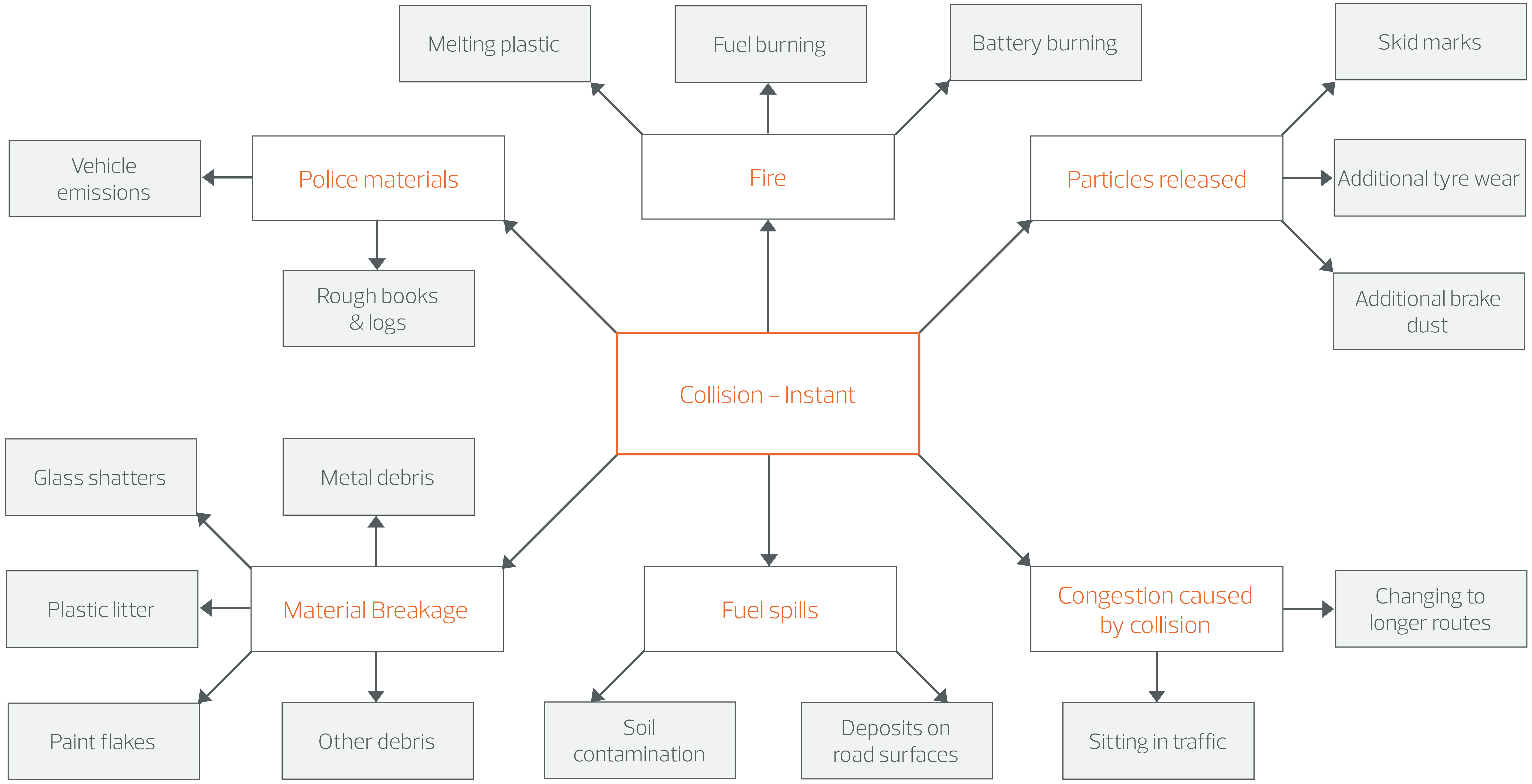

Figure 4: the collision – immediate category split into detail

3.2 Human Environmental Costs

To further understand how a collision would impact the environment, the human environmental costs were investigated. The human environmental costs focused on the environmental impact of dealing with the persons involved in the collision. This begins with the trip to the hospital and the environmental impact the ambulance has on the environment as noise pollution, light emissions, air pollution and fuel emissions. During a patient's hospital visit the environment would be impacted through the length of stay and amount of consumables, maintenance and treatment needed by a patient. After the hospital visit it depends on the patient's level of injury for the future environmental impact, with the eventual death also considered.

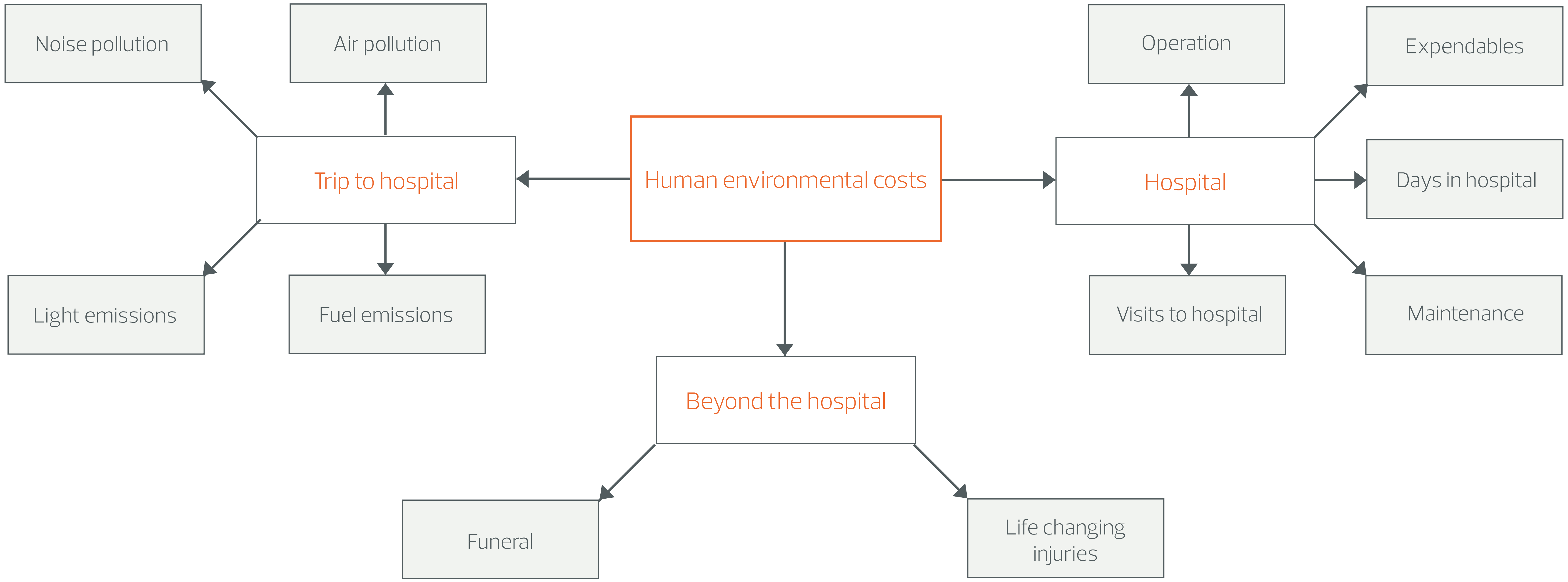

Figure 5: the human environmental costs

3.3 Material – Prolonged

The last category looks at the damage caused to the vehicles and the surrounding site and the need for repair, scrapping and replacing the vehicles. Repairing parts, be it in the vehicle or on site, would require energy and material input, hence harmful emissions and waste. If the vehicle is heavily damaged, a towing vehicle is also needed to transport it away from the collision site, which in turn would result in emissions. Scrapping the vehicle also produces waste that could harm the environment of the scrapyard.

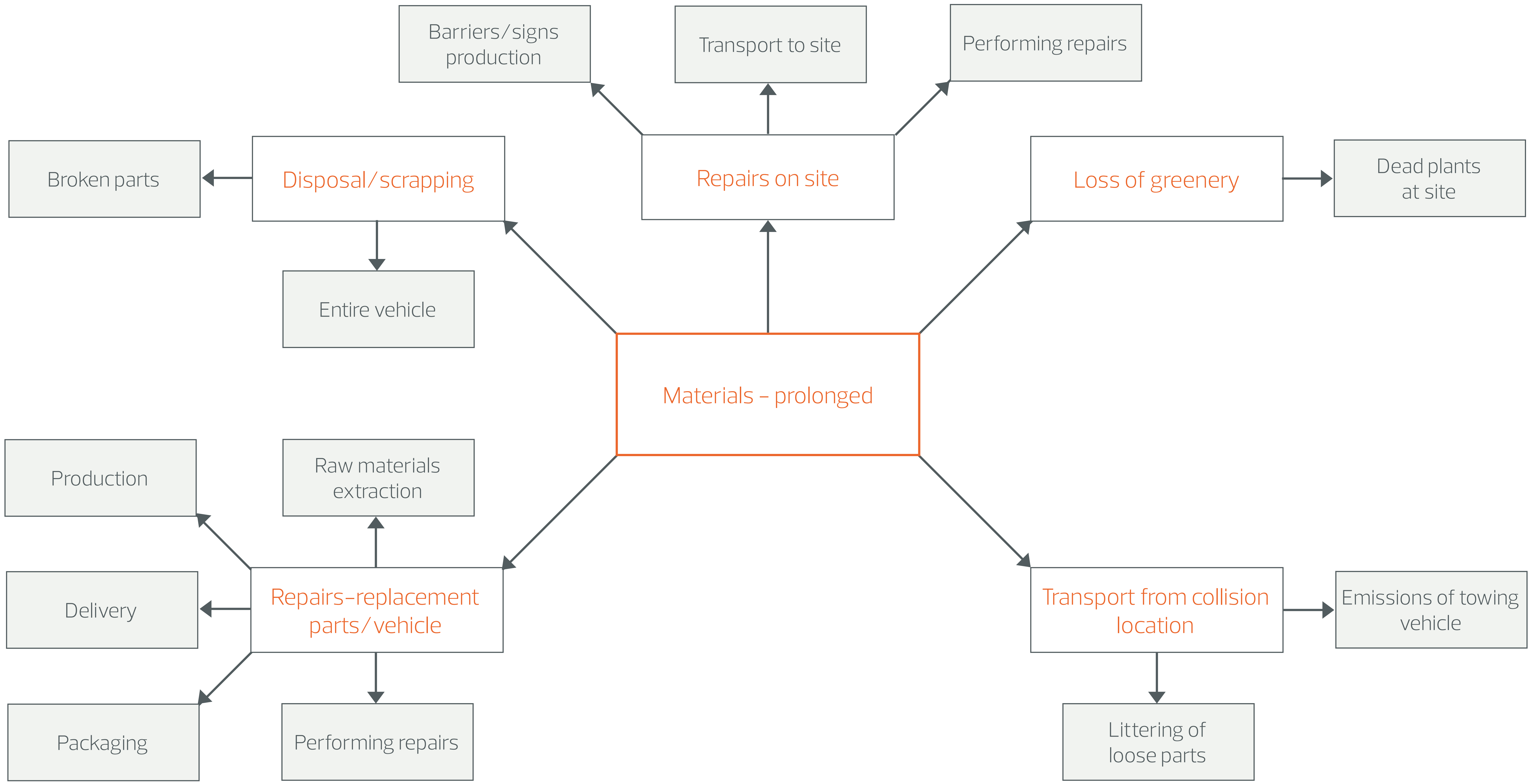

Figure 6: the materials prolonged category for environmental impacts

4 Model Preparation

Our model uses many of our identified impacts to assess the overall effect of a collision on the environment. For each individual cost in our model we found the overall greenhouse gas equivalent that would be produced for a collision. Due to some collisions being more severe than others, our model takes into account a variety of factors (for example distance to the nearest hospital and severity of any injuries), so that the model varies based on the specific situation. The model will easily calculate the environmental impact just as previous models have done with the societal costs of collision casualties. This should allow the environmental costs to be appropriately balanced against the casualty costs.

The model takes a modular approach where costs can easily be added or removed. This allows for easy future improvements and development. It also means that the costs can be presented separately for the three categories that we have identified (human, material – instant and prolonged).
The model will allow transport authorities (from national to regional or county level) to understand the extent of the environmental costs associated with collisions, and provide information to make substantial changes to positively benefit the environment. This will be done via an interactive dashboard. In this dashboard the user will provide information about the collision site that they want to investigate. The model will estimate the environmental costs of an average collision at the site using the information provided.

In a situation where the local authority is considering implementing road improvements schemes the tool would be used to estimate the reduction in environmental costs of collisions at each site. This would help identify which road improvement scheme has the potential for the greatest reduction in environmental costs. The decrease in environmental costs could be used to prioritise spending more appropriately, and/or to justify road improvement schemes which may otherwise be ignored.

5 Summary

In recent years, the interest in the effect on the environment from different sources has multiplied. The world has become environmentally focused due to the detrimental effects of climate change already experienced including floods, droughts, and further severe weather conditions. Governments have implemented strategies to monitor and control climate change however, the environmental aspects of collisions have been overlooked. Instead, Governments have focused on the societal and human costs of collisions that result in casualties.

The model ensures the environment is no longer an afterthought. It will help to emphasise the importance of the environmental impact of improving road safety. It will help to prioritise the air we breathe as an important factor in prioritising spending on road schemes.

While creating the model, the environmental aspects have been considered and included and categorised in three different categories that were examined in depth. These categories focused on both short term and long-term environmental impacts as well as environmental impacts of humans and materials. This model provides a quantification of environmental outcomes can be calculated for transport authorities and governments. This will help to inform meaningful changes to improve local and regional environments for the health of people and to delay the detrimental impacts of climate change.

Overall, the model ensures the environment is no longer an after-thought when a collision has occurred and can be balanced appropriately with the societal costs of casualties, instead of being ignored. It calculates the total emissions of a vehicle collision, highlighting the importance of eliminating those emissions. By improving the roads and/or the vehicle standards, as well as working on specific collision sites, significant environmental impact can be avoided by a more informed prioritisation of the total societal effect of collision reduction.

5 About the Authors

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Alix Edwards is Head of Transport for Sustainable Development, generating strategies to reduce road casualties and lessen the impact of transport on our climate.

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Stacey is an environmental researcher with expertise in air quality, environmental issues and solutions (particularly those experienced in China), and field research.

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7 About TRL

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- We publish software that helps the world's largest cities, and many smaller towns too, reduce pollution, carbon footprint and congestion with advanced traffic management, better road design and good asset management
- We conduct leading edge research into infrastructure, vehicles and human behaviours which enables safer, cleaner, more efficient transport
- We deliver detailed incident investigation, structural survey and other high value field services to help clients to improve the service they give their customers
- We work with universities and other partners to invest in basic and applied research that will underpin future needs
- We have built, with partners from government and industry, the Smart Mobility Living Lab: the world's first physical and virtual testbed in a global megacity (London) that lets companies test new mobility products and services safely on live public roads
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Transport Research Foundation (TRF)

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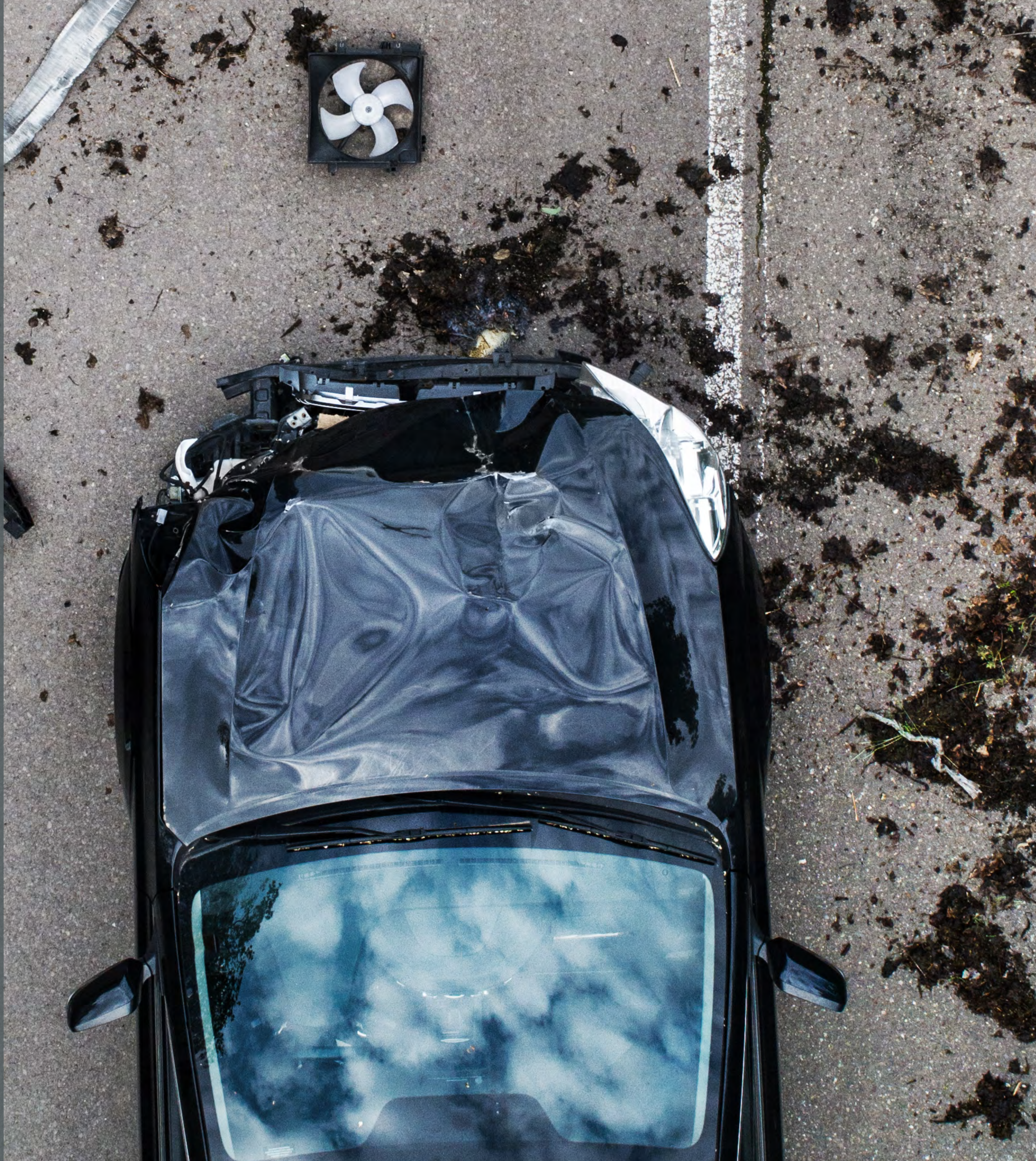
THE FUTURE
OF TRANSPORT

Transport is a key contributor to climate change, and there are many strategies in place to tackle the problem, ranging from clean air zones, to decarbonisation of vehicles. However, a key area of emissions has been missing from the different policies. For a long time now, vehicle collisions have only ever been looked at from a safety and economic perspective. Nevertheless, crashes are not green, saving lives saves the earth too.

This paper looks at the environmental impact of vehicle collisions. TRL has begun modelling to quantify the emissions that result from collisions. We consider different phases of the crashes, and different outcome severities. This modelling can further help inform decision-making in transport policies, both at local and national level. Safety and environmental decisions can go hand in hand.



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