Application for the Development of a Green and Smart City

Project Result 1:   **Theoretical Framework**

Activity 7:   **Development of Theoretical Framework**

Cities Going Green:

Application for the Development of a Green and Smart City

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Partners

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Development of the Theoretical Framework (PR1A7)

Objective of the current document:

This document includes the theory on certain topics, which will later on be used for the development of the Cities Going Green application.

Environmental Sustainability

Learning about environmental sustainability aims to cultivate a sustainability mindset from childhood "with the understanding that humans are part of and depend on nature" (Greencomp, 2022). Learners are equipped with knowledge, skills and attitudes which help them become agents of change and contribute individually and collectively to shaping futures within planetary boundaries. Learning about environmental sustainability could be a catalyst for change among young and adult generations, by acquiring competences that are related to sustainability (Greencomp, 2022).

In this context, seven topics were decided as the theoretical foundation, upon which the Cities Going Green app will be based:

- Circular Economy
- Air Quality
- Green Energy
- Water Quality and Management
- Buildings
- Public Transportation
- Quality of Life (to include several features from the above topics)

The aforementioned topics are significant factors toward environmental sustainability, either as a response to certain environmental threats, or as determinants for the equilibrium in various ecosystems, which consequently affect environmental sustainability.

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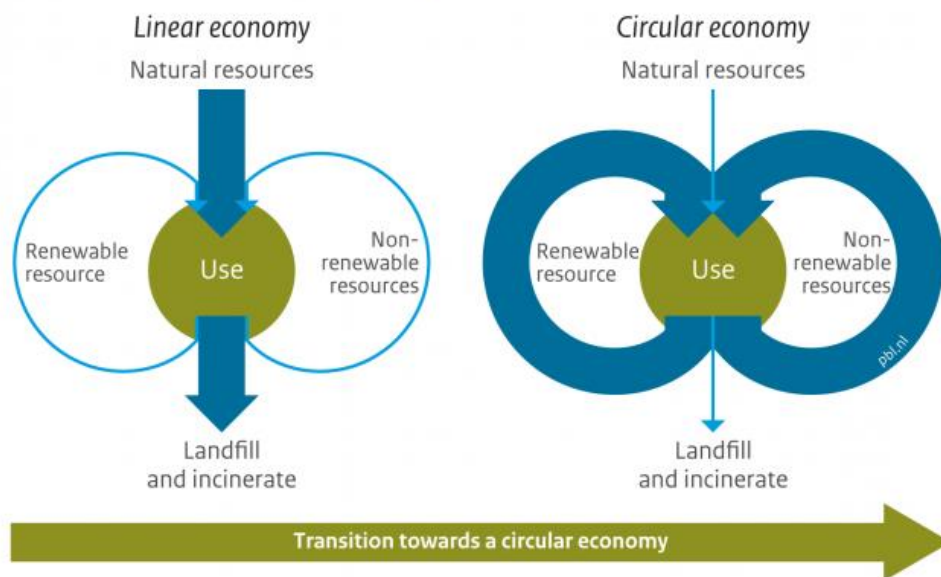Activity 7: Development of Theroretical Framework

Circular Economy

A circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible (Wikipedia).

- In a circular economy, the value of products and materials is preserved **as long as possible.**
- Waste is generated and resources are consumed **as little as possible**, and when the product reaches the end of its life cycle, it is used to create new value.
- This can have greater economic benefits, contributing to innovation, economic growth and **job creation**.
- The circular economy promotes **long-term sustainability** and competitiveness.

This can have greater economic benefits, contributing to innovation, economic growth and job creation. The circular economy promotes long-term sustainability and competitiveness.

From a linear to a circular economy

Source: PBL 2016   www.pbl.nl

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Linear economy problems

- Some resources are becoming scarce. We cannot afford to throw these into landfill – we must extract and re-use the minerals.

- The other problem is the impact of continuous extraction and dumping on our environment. Even best-practice mining uses land that could otherwise be left in its natural state. Clearing land for crops to manufacture clothes means there are less trees and less land for farming. Waste from city areas needs to be transported long distances to landfill sites. This uses significant amounts of energy and contributes to air pollution.

Strategies to Teach

- Strategies aimed at smarter product use and production are most beneficial, changing consumption and production patterns through the use of raw materials and resources and reducing waste generation.

- The second type of strategies are not so radical, but they support the reduction of the consumption of raw materials and resources and thus have a positive impact on our environment by extending the life of products and their parts (e.g., reuse, repair, renovation, remanufacturing, etc.).

- The strategies of the third category are already widely used, but they have so far been the least effective in solving environmental problems. These include strategies for the beneficial use of materials through recycling or energy recovery.

In Building Industry

- Encouraging planning and design based on Building Model Design (BIM).

- Encouraging recycling of materials

- Increasing the energy efficiency of buildings and promoting health friendliness

- Encouraging the use of wood in construction

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In Plastic Industry

- Regulation of placing plastic packaging on the market

- Standardization of packaging

- Circular economy is supported by investment principles

- In fulfilling the circular economy goals related to packaging, the highest priorities are:
  - Reduce single-use plastics
  - Increase plastic recycling

In Textile Industry

- Creation of a cooperation platform for the involvement of companies in the field, public institutions and other interested parties

- Development of effective collection and sorting systems

- Encouraging the reuse and recycling of clothing and textiles through the application of various existing recycling technologies

In Forestry and Wood Industry

- Forestry that ensures high-quality raw wood

- Encouraging the use of wood in construction

- Increasing the reuse of wood

- Replacing products based on non-renewable resources with wood-based products (their development and production)

In Food Industry

- Supporting the creation of circular economic production processes

- Innovation supporting the circular economy

- Supporting companies in reducing food waste

- Integrating sustainable food use and circular economy into the activities of educational institutions

- Raising the awareness and capacity of all parties on the subject of the circular economy

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Footwear Lifecycle
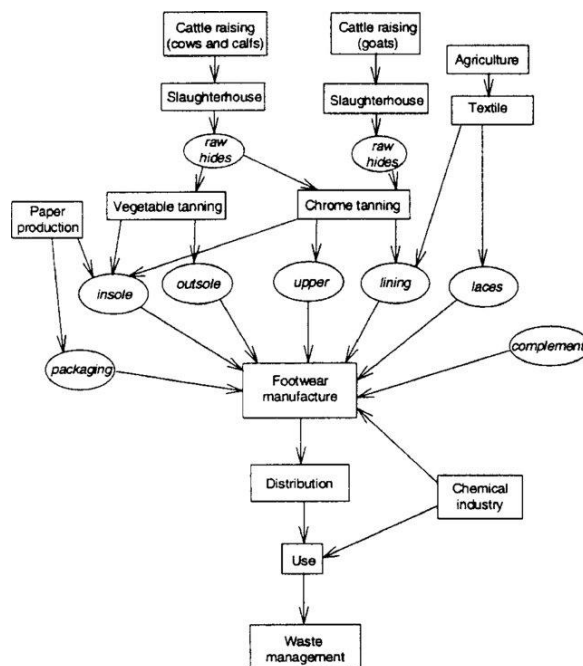
Summary

In summary, a circular economy is a sustainable model of production and consumption that aims to preserve the value of products and materials, minimize waste generation, and contribute to economic growth and job creation. Strategies to promote a circular economy include smarter product use and production, reduction of raw material consumption, reuse, repair, renovation, and recycling. Different industries, such as building, plastic, textile, forestry and wood, and food, have specific goals and strategies for promoting a circular economy.

Air Quality

Air pollution is mostly invisible to the human eye, but nevertheless affects life on Earth. Air is an element of the environment that knows no boundaries, and it is essential for all life. Therefore, its quality and the impact that each person has on its purity is not insignificant. Protecting air quality is very important for the health and well-being of present and future generations of Earth's inhabitants.

Therefore, its quality and the influence that each individual has on its purity are not insignificant. Analyses carried out within the framework of Air Protection Programmes indicate that millions of inhabitants are exposed to poor air quality caused by particulate matter PM10 (Suspended dust PM 10) significantly exceeding the standards. Practically everyone breathes air containing benzo(a)pyrene.

Sources of air pollution

Air pollutants are all substances in the form of gases, liquids or solids (dust), which are not its natural components or occur in concentrations higher than natural.

In the past, the only source of pollution was natural processes, such as: volcanic eruptions, forest fires, atmospheric discharges and the decomposition of organic substances. As a result, they produce: carbon monoxide (II), nitrogen oxides, methane, dust and volcanic gases, e.g. Carbon monoxide.

For many years, societies have believed that it is the industry operating in a given area that is responsible for air pollution. The development of the automotive industry and industry has increased the demand for energy produced from raw materials such as crude oil, natural gas and hard coal. During their combustion, oxides of carbon, sulfur and nitrogen are formed.

The concept of pollutant emissions is inherently associated with tall chimneys of industrial plants. In fact, urban and rural residents emit significant amounts of pollutants into the air during the heating season, such as PM10, PM2.5, carbon dioxide or hydrocarbons, as well as benzo(a)pyrene. The largest exceedances of pollution standards are due to the combustion of solid fuels in domestic stoves and boilers, as a result of burning garbage (which is considered pathological behavior) and due to the increasing number of cars on the road. In places where pollutant concentration standards are exceeded, smoking in boilers and stoves during the heating season is responsible for almost 60% of the concentration of PM10 particulate matter and 74% of benzo(a)pyrene.

Changing this state requires extensive environmental education on air protection. Increasing public awareness of the impact of air quality on health and the impact of each person on air

quality is necessary to achieve the desired effects and change the situation in the perspective of several years. Achieving this is one of the goals of effective environmental education.

Effects of air pollution

Air pollution has a negative impact on the natural environment. Their most dangerous effects are: acid rain, intensification of the greenhouse effect, ozone hole, smog, dust, soil and water pollution. Research shows that in the 20th century the temperature on the surface of our planet increased by 0.6°C.

1. **Acid rain** is formed when air polluted with sulfur and nitrogen oxides, combining with water or water vapor contained in the air, falls with rain or snow to the ground. This precipitation causes environmental damage, accelerates the corrosion of metals and the destruction of buildings.

2. **The greenhouse effect** occurs as a result of the accumulation of carbon monoxide and water vapor (as well as methane, nitrogen oxides, CFCs and ozone), which trap heat in the atmosphere. The result is global warming, which can lead to melting of glaciers, rising sea and ocean levels, and climate change.

3. **Ozone hole**

In the upper atmosphere, at altitudes between 15 and 50 km, our planet is surrounded by an ozone layer (O_3). It is a natural sunscreen that protects the Earth from excessive ultraviolet (UV) radiation. This radiation is necessary for the production of vitamin D in our body, but its excess can contribute to the reduction of the body's immunity and cause skin diseases and an increase in cancer, increase in air temperature and climate change.

As a result of environmental pollution, especially in spring over Antarctica and to a lesser extent over the Arctic, the ozone layer becomes thinner and the so-called ozone layer is formed. ozone hole, through which a significant part of harmful radiation reaches our planet.

Ultraviolet radiation is invisible and imperceptible to us. Burning and pain caused by its excess is a reaction to skin damage. Therefore, you should:

• limit the time spent in the sun in the summer months around noon;

• wear clothes made of thicker, dense fabrics, with long sleeves and legs (average cotton fabric blocks only 20-30% of UV radiation);

• wear a peaked cap or a wide-brimmed hat;

• wear sunglasses with UV filters;

• use creams with UV filters.

4. Smog

Pollutants, the main sources of which are car exhausts, heavy industry and households (heating systems), combined with windless weather and high humidity - fog - create smog. Hovering over a city, smog is particularly dangerous for infants, the elderly, asthmatics, people with respiratory and circulatory diseases.

Based on the mode of formation, place of formation and chemical composition, a distinction is made between London smog (found mainly in the winter months) and Los Angeles type smog (found mainly in the summer months).

The impact of air pollution can have a significant impact on human health:

1. Sulfur dioxide SO2

- irritation of the eyes, nose, throat;
- diseases of the upper respiratory tract;
- disorders in the circulatory system;
- destruction of vegetable dyes;
- acceleration of metal corrosion.

2. Nitrogen oxides (NOx)

- irritation of the eyes, nose, throat;
- lung diseases;
- dizziness and headaches;
- destruction of many materials (e.g. alloys)

3. Carbon Monoxide

- highly toxic - even short-term inhalation can cause death

4. Dusts

Substances such as mercury, cadmium, lead and their oxides cause:

- allergies, diseases of the upper respiratory tract
- carcinogenic;
- dying of plants by blocking access to light.

Gaseous pollutants and dust clog the stomata of plants, penetrate inside the plants and destroy chlorophyll.

Air protection

The main sources of air pollution are industry and transport. Gases transported over long distances can contaminate areas far from the source of their emissions. Air protection is therefore a global issue and is regulated by legislation.

Measures to reduce emissions of harmful dust and gases into the atmosphere

- Reducing emissions from mining, metallurgy and power plants.
- Reducing the exploitation of natural resources, reducing electricity consumption and using alternative energy sources.
- Reducing emissions of harmful exhaust fumes by reducing transport, either by purchasing cars with lower emissions or using public transport or cycling.
- Using modern technologies in industry to reduce dust emissions.
- Planting green belts for conservation purposes.

Summary

Education goals

The main goal of environmental education in the protection of air and all elements associated with it must be:

• Indication of reasons why the air should be protected and ways in which it can be done to do it (sensitivity to air quality problems already in children's education and young people)

• Developing the ability to perceive phenomena related to air quality, including the impact of actions and decisions taken on the quality of the air, the effects of exposure to pollutants in the air and appropriate response in such situations (where to get information about air quality and what daily activities and choices affect the amount of pollution in the air?; how to monitor activities in your area?),

• Shaping the emotional attitude to air protection, including the impact of the air we breathe on the health of children, the elderly and the general public, on the destruction of historic buildings, on the degradation of the environment in which everyone lives,

• Forming and strengthening positive beliefs and social attitudes based on awareness of the impact on health and comfort of life and the possibility of influencing the quality of air in their place of residence through social attitude and setting examples in the field of:

- the impact of waste incineration in household hearths,
- combustion in low-efficiency devices,
- principles of efficient use of fuels and methods of reducing heat energy consumption,

- promoting behaviors aimed at giving up the car in favor of public transport, bicycles,
- principles of social responsibility and reacting to inappropriate behaviour, e.g. neighbors.

✓ Air pollution is global in nature. It can come from natural sources or be the result of human activity.
✓ Air pollutants include carbon oxides, sulphur oxides, nitrogen oxides, particulates, freons, among others.
✓ Adverse phenomena caused by atmospheric pollutants are the greenhouse effect, the ozone hole, acid rain and smog.

Consider how you can contribute to reducing atmospheric emissions.
Think about alternative energy sources.

Green Energy

Green energy is a term for energy that comes from renewable sources. Green energy is often referred to as clean, sustainable, or renewable energy. The production of green energy doesn't release toxic greenhouse gases into the atmosphere, meaning it causes little or no environmental impact. For an energy source to be considered green energy, it must fall within the ranges of zero, low or neutral in greenhouse gas emissions during energy generation and operation.

Green energy comes from natural resources like water, wind and sun, which provide the energy we turn into electricity.

 More specific the renewable sources of energy are:

- Solar energy
- Wind power (Wind is the cleanest energy source, as it reduces our reliance on fossil fuels and the amount of dangerous CO_2 that pollutes the air).
- Hydropower
- Biomass
- Geothermal
- Tidal energy

As everyday energy consumers, we all should know where our energy is coming from and its effect on the environment.

There are many reasons why we as a society should focus on green resources of energy. First of all, green energy sources are environmental friendly as they have no greenhouse gas emissions and the natural resources of the earth are not extracted so the earth stays mostly induct. In addition, green energy is better for our physical health as it is far less responsible for polluting our air and water. According to the World Health Organization, household and ambient air pollution causes 4.2 million deaths around the world annually. Another advantage of green energy is that the naturally occurring resources used to harness this renewable energy will not deplete over time.Last but not list, by increasing the usage of green energies such as solar panels, wind turbines and other technologies we are reducing our dependency on non-renewable resources such as natural gas and oil which are determined to run-out at some point.

Water Quality and Consumption

Water Quality and Management was characterized as a crucial topic toward environmental sustainability by the consortium of the Cities Going Green project.

The importance of water quality and access for the wellbeing of humans is extremely significant, since "absent, inadequate, or inappropriately managed water and sanitation services expose individuals to health risks" (WHO, 2022).

This particular topic is aligned with the United Nations' Sustainable Development Goals 2015-2030. Some of those goals are SDG 6: Clean Water and Sanitation, SDG 12: Sustainable Consumption and Production and SDG 14: Life Below Water. (UN, 2022) Those Sustainable Development Goals also have an impact on other SDGs and other threats that need to be addressed.

Water Quality and Management involves both the access to potable water and water conservation. Nowadays, water scarcity is either a reality or a visible threat in many countries.

UNICEF (2022) exhibits some truly worrying facts regarding water scarcity and signifies the fact that water scarcity should be considered a serious global threat:

- Four billion people — almost two thirds of the world's population — experience severe water scarcity for at least one month each year.

- Over two billion people live in countries where water supply is inadequate.

- Half of the world's population could be living in areas facing water scarcity by as early as 2025.

- Some 700 million people could be displaced by intense water scarcity by 2030.

- By 2040, roughly 1 in 4 children worldwide will be living in areas of extremely high water stress.

In addition, the quality of potable water is compromised because of the negative impact of human activity.

This applies both for water used by humans but also to life underwater. Oil spills, agrochemicals and plastics are some of the modern threats toward the sustenance and balance of food chains and the wellbeing of life underwater (WWF, 2022).

"Whether we live near or far from the ocean, our lives depend on it" (WWF, 2022).

Buildings

Urban design

Urban design is the design of towns and cities, streets and spaces. It is the collaborative and multi-disciplinary process of shaping the physical setting for life – the art of making places. Urban design involves the design of buildings, groups of buildings, spaces and landscapes, and establishing frameworks and procedures that will deliver successful development by different people over time.

Urban design:

- Defines the nature of buildings and the spaces between them.
- Defines how the design itself should be worked out: design processes and outcomes.
- Inspires, illustrates and defines how a place could be improved or protected to bring benefits to investors, developers and wider society.

Urban design draws together the many strands of place making, environmental stewardship, social equity and economic viability into the creation of places with distinct beauty and identity. It creates a vision for an urban area and then deploys the resources and skills needed to bring the vision to life.

Green architecture

Green architecture, or green design, is an approach to building that minimizes harmful effects on human health and the environment. The "green" architect or designer attempts to safeguard air, water, and earth by choosing eco-friendly building materials and construction practices.

Green architecture defines an understanding of environment-friendly architecture under all classifications, and contains some universal consent. It may have many of these characteristics:

- Ventilation systems designed for efficient heating and cooling
- Energy-efficient lighting and appliances
- Water-saving plumbing fixtures
- Landscapes planned to maximize passive solar energy

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- Minimal harm to the natural habitat
- Alternate power sources such as solar power or wind power
- Non-synthetic, non-toxic materials
- Locally-obtained woods and stone
- Responsibly-harvested woods
- Adaptive reuse of older buildings
- Use of recycled architectural salvage
- Efficient use of space

While most green buildings do not have all of these features, the highest goal of green architecture is to be fully sustainable. The overarching goals of building "green" are to reduce the social and environmental impacts of the built environment while improving the quality of life for occupants within buildings.

Green buildings

Green buildings are made in accordance with the principles of green architecture. They are designed, constructed, and operated with a focus on conserving energy, sourcing eco-friendly/recycled materials, and preserving the biodiversity of the area.

Think solar panels, commercial composting toilets, and rainwater harvesting. Also, consider things like improved resiliency guidelines that account for natural disasters to create longer-lasting buildings. These initiatives are becoming more commonplace, and they all represent ways that infrastructure can minimize its environmental footprint.

Certified groups and individuals come together to make green buildings a reality. The process begins even before breaking ground with site surveys for topography, drainage/soil samples, and sun patterns. The role of architects and engineers might be to design a natural ventilation system to offset air conditioning use, then to work with builders and local organizations to source sustainable materials.

Once constructed, building tenants play their part to minimize their own energy, water, and general resource use within the structure. Each group fulfills an important role in making the building more environmentally friendly.

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Smart buildings

A smart building is an implementation of a smart (connected) world. A smart world, like a smart building is, for the most part, only different from the IoT (internet of things) in name; both the IoT and smart worlds share the same frameworks, benefits, and challenges. The subtle difference between the generic IoT and a type of smart world is that a smart world usually describes the usage of an IoT network in a specific implementation or industry, in this case, a smart building.

Smart buildings include private homes, offices and commercial buildings, workplaces, and factories and warehouses.

Smart buildings deliver actionable information about a building itself or a specific room inside it so that owners or tenants can better manage it. The term smart building usually refers to commercial buildings, while the term smart home usually refers to private residences, but much of the functionality is the same and so the terms overlap.

The goal of creating a smart building is to reduce operating expenses, improve occupant comfort, automate energy consumption management, track the status of core building assets, and meet global regulations and sustainability standards in the industry.

To be effective, smart buildings require complex monitoring of the IoT networks that control the building system.

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Public transportation

Addressing sustainable mobility from the school environment is quite a challenge. It is not a question of working on road safety education, but of committing to an education for mobility understood from respect, responsibility and autonomy, that is, from education in values since we have to commit to collective well-being and understand the needs and possibilities of mobility of each citizen.

Sustainable mobility is characterized by the set of trips that are made with the purpose of traveling the distance from the place of origin to the destination, reducing the negative impacts on the environment. It concerns both public transport (buses electric or zero emissions, metro, train, tram, etc.) and private (pedestrian, bicycle, scooter or electric vehicle, etc.).

The increase in greenhouse gas emissions caused by transport is of increasing concern, especially in cities, where air pollution rates are beginning to be considered a risk to public health. Sustainable mobility contributes to reducing harmful emissions, and therefore, to reducing air pollution and improving air quality in cities.

Transport has a very considerable weight in the framework of sustainable development due to environmental pressures, the associated social and economic effects and the interrelationships with other sectors. The continuous growth that this sector has been experiencing in recent years and its foreseeable increase, even considering the change in trend due to the current situation of generalized crisis, make the challenge of sustainable transport a strategic priority at local, national and , European and global.

Transport is one of the sectors that negatively influences the environment in two ways. On the one hand, the pollution it causes is one of the main causes of the so-called greenhouse effect (climate change) and the emission of toxic substances into the atmosphere. that affects our health, and on the other hand, the need for new transport infrastructure (highways, railway lines, ports) to try to solve the collapse of those that already exist.

Sustainable mobility: good habits to adopt on a daily basis

- 20 minutes to walk is a more than reasonable time (just over 1.6 km).
- A 30-minute bike ride (i.e. 9 km) can be used to go shopping or to work.
- 2 hours by train for a business trip and 4 hours by train for a weekend trip are cheaper and more environmentally friendly than the plane.

- Share the car, for example with your co-workers.
- Adopt an efficient driving style: the way you drive also influences fuel consumption.

What are the sustainable transports of the future?

- In recent years, along with traditional bicycles, rollerblades and skateboards, many new forms of transportation have appeared.
- The electric bicycle increasingly replaces the car in medium distances, reducing CO2 emissions by 100, but also costs.
- The electric scooter emits less CO2 than the car but more than public transport. In many cases, the car is not replaced, but the bicycle, the walk, the bus or the subway.
- The hydrogen vehicle is a new type of transportation that is increasingly promoted by cities, especially for buses. It must be equipped with fuel cells, which allow hydrogen to come into contact with oxygen and create electricity.

Main goals

- Work on students' previous knowledge to promote reflection on the most important problems of mobility.
- Make students aware of the importance of sustainable mobility and the environmental effect of the different types of transport
- Intelligently and efficiently optimize the use of materials, energy and information and minimize the environmental impacts of urban and interurban transport to meet the mobility needs of goods and people, both locally and globally.
- Reflect on the means of transport that facilitate our mobility and accessibility needs at all times, emphasizing those forms of displacement that contribute to respecting the environment.
- Encourage a critical and constructive spirit to seek possible solutions to the problems of their immediate environment, promoting travel on foot, by bike and by public transport.
- Know the main means of transport in your municipality and the consequences of their use, especially those related to the environment. Making contact with concepts such as carbon monoxide (CO), carbon dioxide (CO2) and black smoke (HN)
- Produce, consume and move people and goods better, with less and less environmental impact.

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