

Can you keep it cool? *The rise of global warming*



Learners at
Fridays4Future protests
in Pietermaritzburg,
KwaZulu-Natal

Pic: Jive Media Africa

It's that time again – yes, that's right, it's **Spaza Space** time!

We hope that everyone had a great third term and that you're ready to take on the end of year exams!

The second half of the year has brought **National Science Week** with it, and this year's theme was "facing the harsh realities of climate change". **Climate change** is here, and it's time to take action! Find out more about climate change on this page, read the articles by climate change researchers and make your very own climate change booklet that comes with this edition (see the instructions for making your booklet on page 3).

Then find out what we did for National Science Week (Hint: It's **AWESOME**). Check out our interviews with **women in science** who we celebrated for Women's Month. Lastly, check out news from our awesome clubs on page 8.

We hope you enjoy this edition of *Spaza Space*!

*The Science
Spaza Team*



Spaza Space is the official publication of the Science Spaza programme, which is an initiative of research communication specialists, Jive Media Africa.

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We are talking to our future leaders. Are you?

Here's the 411...

OKAY, GUYS, HERE ARE A FEW TERMS THAT YOU NEED TO UNDERSTAND BEFORE YOU CAN GET A GRASP OF CLIMATE CHANGE ...



WEATHER: day-to-day conditions in our atmosphere



CLIMATE: the average of weather conditions over a long period of time



THE GREENHOUSE EFFECT:

A natural process that takes place when gases in the earth's atmosphere trap the sun's heat. This makes the earth a warm and comfortable place to live.



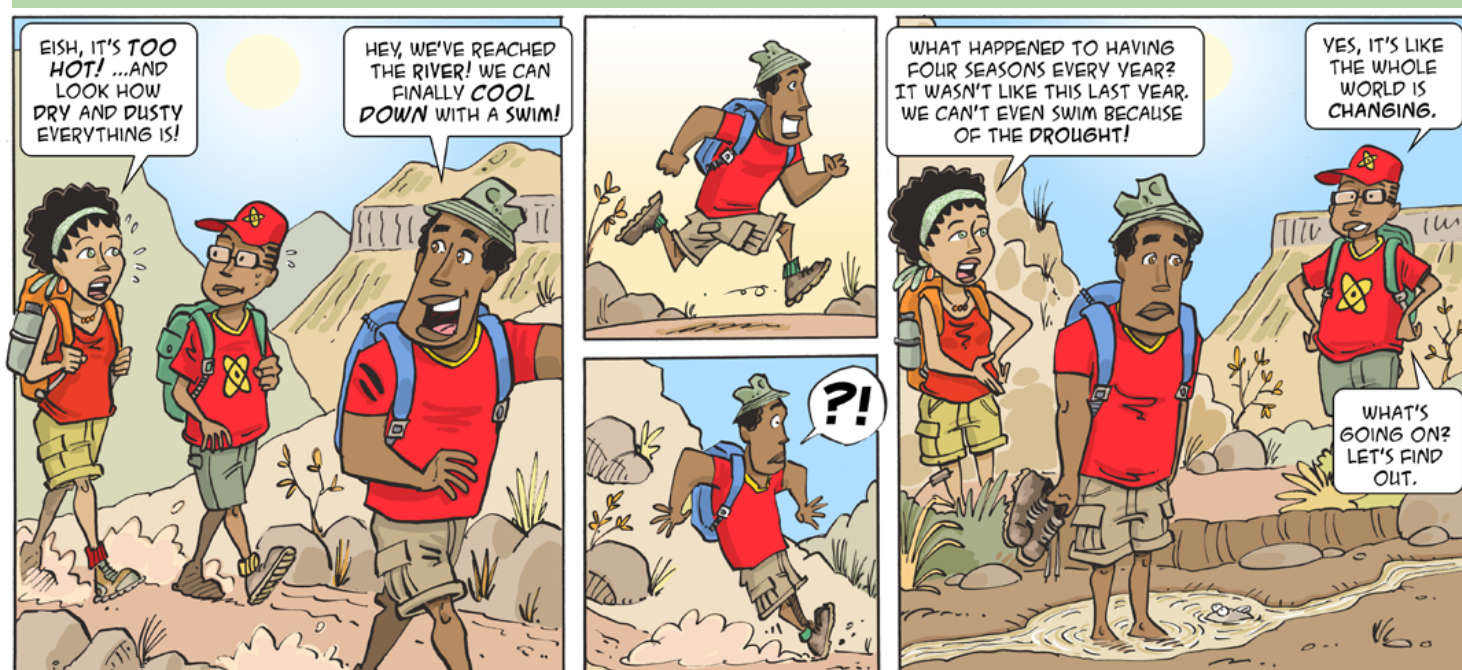
So, what's global warming got to do with it?

"Global warming" refers to the trend of average global temperatures rising over a long period of time. BUT, over the past 50 years, the average global temperature has increased at the fastest rate ever recorded!

This rapid increase in the average global temperature is happening because of the increase in carbon dioxide (CO₂), other pollutants and greenhouse gases which collect in the atmosphere and absorb sunlight and solar radiation that has bounced off the earth's surface. Normally, the heat from sunlight and solar radiation would escape through the earth's atmosphere, but

these gases and pollutants trap the heat, which intensifies the greenhouse effect and causes our planet to get hotter!

According to the Intergovernmental Panel on Climate Change (IPCC), the earth's temperature has risen 0,74°C. Now, this may not sound like a lot, but its effect is HUGE. One of the most visible impacts of the earth's warming is on glaciers and ice sheets, which are melting at a rapid pace, causing ocean levels to rise, and causing a loss of habitat for many species that live in places like Antarctica.



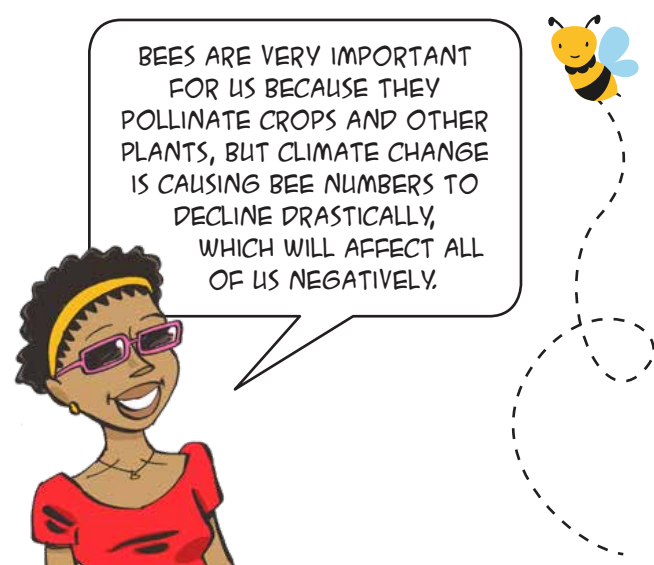
Be sure to keep an eye out for the air quality booklet in our next edition!

Climate change – it's here!

The increase in the earth's temperatures through global warming and the changes that it brings to our climate mean that our weather will become more unpredictable and extreme. In some cases, humans and animals may not be able to adapt to changes in the weather.

Rising global temperatures put human health at risk, increase the occurrence of extreme weather and cause damage to ecosystems. Here are some of the impacts of climate change:

- Heatwaves
- Heavy rain
- Drought
- Wild fires
- Sea level rise
- Threats to animals and their habitats
- Ocean acidification



Looking back in time



An ice core segment. Pic: NASA's Goddard Space Flight Center / Ludovic Brucker

Scientists study things that have been around for a long time, so that they can get a better understanding of what the earth's climate was like a long time ago. One of the things that scientists study are trees. Trees that were alive years ago are very useful for telling us what the climate was like back then. The rings inside a tree can tell us how old the tree is, what the climate was like, if there was a fire, and whether the seasons were rainy and dry seasons.

If scientists want to study what the earth's climate was like HUNDREDS of years ago, they study sediment and ice cores. Sediment cores come from the bottom of lakes or the ocean floor. Ice cores are drilled from places where there is thick ice, such as Antarctica. These ice cores give us clues about the earth's history, right up until the last layer was formed. The ice layers contain bubbles of air from each year, which scientists analyse to determine how much carbon dioxide (CO₂) they contain.

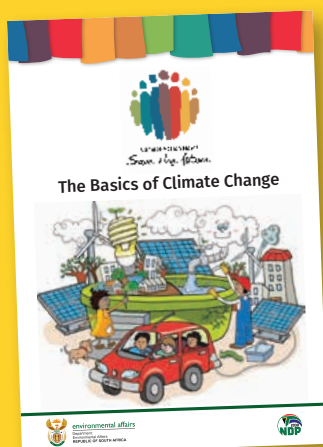


Tree rings in a cross section of a tree.

Pic: Wikimedia Commons / Arnoldius

To find what the causes and impacts of climate change are and to learn more about the impacts of climate change, check out our **climate change** booklet, created in partnership with the Department of Environmental Affairs.

Take the 2 booklet sheets out of your Spaza Space publication.



Fold & Cut!

MAKE YOUR OWN BOOKLET TO LEARN MORE ABOUT CLIMATE CHANGE

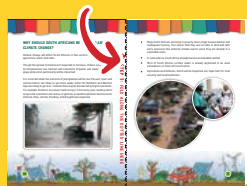
1 Fold along the dotted line here



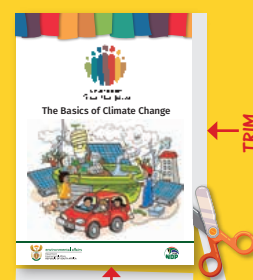
2 Fold along the dotted line here



3 Fold along the dotted line here



4 Trim off the white border on the bottom and right hand side of your booklet. Be careful not to cut the spine!



5 Carefully cut along the line at the top of the booklet and staple the booklet's spine to hold all the pages together.



Now you can learn more about climate change!

Is climate change bad for your health?



Sabeehah Vawda

“Sjoe! This has got to be the hottest summer I have ever experienced, and mind you, I have been living here since I was born. I’m telling you – this climate change is bad.”

We all have conversations about the weather, mostly because a discussion on the weather is the perfect conversation starter and what better way is there to fill-up that awkward conversation gap, right? As normal as the weather may seem, everyone experiences it on a daily basis, and so a weather discussion can result in quite lively conversations. Nowadays, the term climate change is sure to pop up in casual conversations about the weather, directly related to the level of discomfort that someone is experiencing, and is generally used at the end of the conversation. One that no one can argue with. The grand finale to the weather discussion.

In reality, while the term “climate change” has become quite popular in casual conversations, print media and social media, very few people actually understand the impact of climate change. Climate change is about more than JUST the weather. For example, has it ever occurred to you that climate change may have a huge impact on your health? Possibly not; you may have had to think a bit about that one. So how does climate change affect your health?

Extremes of temperatures are obviously not good, and with climate change causing an increase in the average global temperatures, it’s definitely going to become much warmer. Continuous exposure to hot conditions can result in many heat-related illnesses ranging from sunburn to heat exhaustion, heat cramps, and the dangerous sun stroke (or heatstroke). While these may

happen to literally anyone, the very young, the very old, individuals with underlying medical conditions, those with weak immune systems, and those who do not have proper clothing and/or housing, are at a higher risk. Higher temperatures also result in an increase in air pollution and pollen, which could trigger asthma and worsen other cardiovascular and respiratory diseases. Believe it or not, temperature extremes can have effects on your mental health too, which may eventually affect your work and relationships.

It already sounds pretty worrying right? Unfortunately, there’s more. There are many indirect health effects of climate change as well. Weather-related natural disasters are on the rise. An increase in droughts will lead to unreliable levels of food production, leading to hunger and famine. Increase in floods will lead to local devastation and disruption, with injuries and death, and affected individuals will be exposed to unclean water sources. This will lead to an increase in infectious water-borne diseases such as bilharzia. The recent cholera outbreak in Mozambique, following Cyclone Idai, is just one, close-to-home example.

Insect and snail populations are also sensitive to climate change. Increasing temperatures would mean a wider distribution of vector-borne diseases (diseases which cause human illnesses, caused by parasites, viruses and bacteria carried by insects) such as malaria which is carried by mosquitoes, and possibly an escalation in the number of people infected.

So yes, climate change will definitely impact on health. According to the World Health Organisation, climate change will result in approximately 250 000 additional deaths per year, between 2030 and 2050. These would be as a result of heat stress, malaria, diarrhoea, and malnutrition.

So the next time you are having one of those well-known weather conversations, don’t forget about all the serious health effects of climate change. Try to steer the conversation to ways that we as individuals can impact climate change – waste less food, switch to a more plant-rich diet, save energy in our homes and using public transport are just some examples. The group effort of small changes can make a huge impact. Let’s do our part in the fight against climate change.

PUZZLE YOUR MIND

CLUES: ACROSS

- state of extreme tiredness
- prolonged period of very hot weather
- human disease involving water snails
- human disease following the bite of a mosquito
- another word for heatstroke

CLUES: DOWN

- make or become different
- average weather conditions over time
- old or aging
- feeling of discomfort due to lack of food
- extreme scarcity of food
- attacks of breathing difficulty
- related to the mind
- painful muscle contractions
- state of being free from illness
- the star around which the earth orbits

Answers – Across 1. exhaustion; 2. climate; 3. elderly; 4. hunger; 5. famine; 6. asthma; 7. mental; 8. cramps; 9. health; 10. sun
Down: 1. change; 2. climate; 3. elderly; 4. hunger; 5. famine; 6. asthma; 7. mental; 8. cramps; 9. health; 10. sun

The hot zone; climate change and infectious diseases

While the spread of exotic infectious diseases makes you think of scientists in protective suits running around the forests of far off places, the threat is actually much closer to home. It is becoming obvious that climate change not only affects our natural resources; the availability of water, fertile land and extreme weather conditions, but it also affects the spread of disease.



Simone Richardson

Diseases are popping up where we have never seen them, and new and developing outbreaks will become more common. Climate change could result in differences in where, when and how often diseases appear. This means that as the environment changes to create the perfect conditions for the spread of devastating and deadly diseases (such as malaria, zika, and dengue), we will see higher rates of illness and death in populations that were previously not exposed to these diseases.

Climate change will probably impact diseases spread by insects, as changes in breeding patterns and increasing reproduction will spread diseases further than ever. More than 90% of malaria-related deaths occur in Africa, where humidity and tropical climate temperatures support the parasites' life cycle. If global temperatures increase by 2 to 3°C, as expected, it is estimated that the population at risk for malaria will increase by 5%, meaning millions of additional new infections. As climate patterns shift, it is possible that malaria will become common in new areas. Malaria has appeared for the first time in the highly populated region of the highlands in east Africa due to higher temperatures.

Climate change will likely affect other vector-borne diseases, like dengue fever, with increases in the spread of this disease expected in areas where higher rainfall and humidity will heighten the breeding of mosquitoes. However, Aedes mosquitoes typically breed in water containers used for household storage, a system which might be used in times of drought. Similarly, tick-borne diseases such as Lyme disease have nearly doubled in the United States, because of their now shorter winters.

Climate change is also lending a helping hand to water-borne pathogens that are found in warmer waters. Increased rainfall affects flooding, sanitary conditions and the spread of diarrhoeal

diseases including cholera. It is predicted that by 2030 there will be 10% more diarrhoeal disease than there would have been without climate change and it will mainly affect the health of young children. Salmonella and other food-borne diseases have been linked to increasing temperatures, a problem that could be worsened in low income countries.

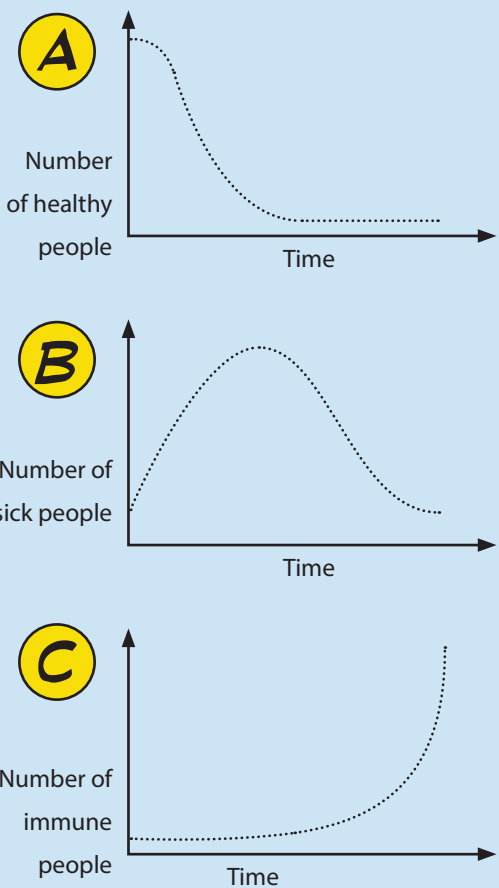
The World Health Organisation has determined that although climate change is a global phenomenon, developing regions have and will be affected unevenly even though greenhouse gas emissions released by developed countries. This includes the United States, which has pulled out of the Paris accord – an agreement to lower emissions and the average temperature of Earth. U.S. President Donald Trump said "The Paris accord will undermine [the U.S.] economy," and "puts [the U.S.] at a permanent disadvantage". This statement has put the reduction of emissions at risk. Governments play a crucial role in reducing climate change because these international agreements form the basis of the policies that will directly affect health, with weak public health institutions likely being affected the worst by climate change effects. We should view the effect on infectious disease as a new sign that climate change will affect us in unexpected and unwelcome ways if we do not have policies and interventions in place by the time South Africa is in the hot zone.

DID YOU KNOW? MATHS CAN HELP US LEARN HOW DISEASES SPREAD

WHEN TALKING ABOUT THE SPREAD OF A SICKNESS, THERE ARE THREE GROUPS OF PEOPLE – **HEALTHY**, **SICK** AND **IMMUNE**.

EACH OF THESE GROUPS HAVE THEIR OWN GRAPH. SEE IF YOU CAN MATCH THE GRAPHS TO THE DESCRIPTION ON THE LEFT.

- 1 NOT MANY PEOPLE ARE **IMMUNE** TO A SICKNESS AT FIRST, BUT AS THEY GET SICK AND THEN WELL AGAIN, THE NUMBER OF IMMUNE PEOPLE GETS MORE.
- 2 LOTS OF PEOPLE ARE **HEALTHY** AT FIRST, BUT AS MORE GET SICK, THE NUMBER OF HEALTHY PEOPLE GETS LESS.
- 3 NOT MANY PEOPLE ARE **SICK** AT FIRST BUT MORE AND MORE GET SICK AS TIME GOES ON. THEN THEY GET BETTER AND THE NUMBER OF SICK PEOPLE GET LESS.



Answers: 1-C, 2-A, 3-B

Marching towards a better future!



The South African Climate Crisis Coalition (SA CCC) is one group that is getting serious about climate change!

The organisation began in 2011 and aims to address the impacts of climate change, while creating awareness and educating the youth of South Africa, who they believe play an important role in creating a sustainable future. The organisation is aligned with other climate coalitions in countries such as New Zealand, Australia, Kenya and Asia, as well as in many other countries.

Every Friday, the PMB CCC hosts a Fridays4Future march in Pietermaritzburg,

protesting against climate change. We visited them at one of their marches outside the Tatham Art Gallery in Pietermaritzburg, where young people from schools in Pietermaritzburg protested against climate change and put on a performance for the public. Here are some pictures of their awesome march and performance – you'll also see that the former Msunduzi mayor, Themba Njilo, was in attendance! Best believe they got a lot of hoots!



Check out this article by Luke Wylde from the PMB CCC. He's the one who took the initiative to organise the Fridays4Future marches in Pietermaritzburg!

Let's get to know the youth behind Fridays4Future better

I am Luke Wylde, 13, and I'm from the Pietermaritzburg Climate Crisis Coalition.

We have a catastrophe that affects all of us in every facet of society, and that catastrophe is global heating and extreme weather conditions. The thing many people don't realise about climate change is that it's not just a few degrees' rise in temperature, but that it causes major temperature fluctuations, like the drought in Cape Town and the floods in Durban.

Climate change disproportionately affects poor and disadvantaged people, as they can least afford to buffer the effects of climate change. But we can effect change, because we all hold the power to affect youth all over the world who are fighting for a future, and everyone has to pull together to fix this problem, because we only have eleven years to stop climate change becoming irreversible. So, we have to act now to save ourselves from this crisis.

If you would like to learn more or join the conversation, you can contact:

- **South African Youth Climate Change Coalition:**
Tel. +27 (0)33 260 6667;
saycccc@secretary.net
- **350.org:** www.350.org
- **Centre for Environmental Rights:**
+27 (0)21 447 1647;
info@cer.org.za

National Science Week 2019

The climate change conversation heated up as we took to the streets to demand climate change action.

Learners from three schools in Pietermaritzburg (St. John's DSG, Maritzburg College and Slangspruit Primary School) put together song and dance performance pieces to express their concerns about our future. They collaborated with researchers and choreographers, and partnered with the PMB Climate Crisis Coalition (PMB CCC) to host a series of events during National Science Week, an initiative of the Department of Science and Technology. The theme this year was "facing the harsh realities of climate change".

Hip Hop Science Spaza created an opportunity for young people to explore how climate change impacts their daily lives and circumstances. Learners met with researchers from the University of KwaZulu-Natal, Research Chair in Waste and Climate Change and team members from the uMngeni Resilience Project to better understand climate science, and to develop songs to share what they had learned. They were also featured on television programme Hectic Nine-9. Be sure to catch their feature on our website!

The learners wrote their hip and happening songs after interviews with the researchers, and then recorded HOT tracks! Then, in association with local dancer and choreographer Bonwa Mbontsi, they created a dance routine to perform at the final event! Thank you to the Department of Science and Technology for supporting this initiative!

CHECK OUT THESE COOL CATS!



NEWS FROM THE CLUBS

EMAIL INFO@SCIENCESPAZA.ORG TO REGISTER YOUR SCIENCE CLUB



The awesome learners from **Tembisa Secondary School** enjoying their Green Chemistry edition of *Spaza Space*.

To celebrate Women's Month, we interviewed Prof. Christina Trois, who is behind some seriously awesome climate change research.

1. Please share a brief biography. Can you think of any noticeable effects of climate change around you?

I am from Sardinia in Italy, and moved to South Africa in 1998. I have been working at the University of KwaZulu-Natal since 1999, and have a PhD in Environmental Engineering from Cagliari University (Italy). I've noticed extreme weather conditions and mini tsunamis in Durban, and extreme droughts in Cape Town.

2. What did you study? Where? What was your field of focus? If you are still studying, please provide a short description of your work.

I studied in Italy, at the University of Cagliari. I am an engineer by profession, but have followed my passion into research, and am a C1-rated scientist with the National Research Foundation.

3. What inspires you about your work/career? What gets you going in the morning?

Finding real solutions to environmental problems. What has inspired me throughout my career and life in South Africa is inspiring and shaping new environmental engineers and scientists. I always say that I do not want to change the world, but I want to change many worlds ... those of my students!

4. How did you become interested in the climate change field?

In the past decade, the impact that climate change is having on the environment and human health



PROF. CRISTINA TROIS

has become really clear. Hence, I dedicated my research focus to studying mitigation (to reduce the intensity of something) and adaptation (the process of adapting to survive) strategies concerning climate change, with focus on the waste sector, which is a large contributor to greenhouse gas emissions into the atmosphere.

5. Where are you currently employed? What is your role? How do you focus on climate change in your job?

I am the NRF South African Research Chair in Waste and Climate Change (SARCHI) at UKZN. My focus is studying the impact that the waste sector has on climate change, developing innovative mitigation strategies, and also studying how climate change is influencing the waste sector.

6. What are some of the challenges that you face in your vocational field?

Lack of resources and lack of capacity may create barriers in the application and implementation of

innovative ideas and research. Also, engineering is still a male-dominated environment.

7. What do you think is the future of climate change, especially in South Africa?

I believe that international efforts to reduce GHG (greenhouse gases) emissions into the atmosphere will continue to keep climate change on the agenda, forcing South Africa to pay attention.

8. Why do you think learning about climate change and spreading awareness is important, especially among learners?

The learners of today are the engineers, scientists and leaders of tomorrow. Because our Science/Engineering in South Africa is as good as science anywhere else in the world, and it is also time that our young people understand that and drive change from the African continent.

9. What are some things that South Africans can do to reduce the effects of climate change?

With respect to solid waste, they MUST stop single-use plastic, they MUST stop littering, they MUST demand separate collection of waste from the municipalities. But, most importantly, they MUST start seeing waste as a resource, rather than as a problem that is forgotten the moment trash ends up in the bin.

10. What advice would you give to learners who want to study science?

To get at least a B (and possibly 70% or higher in matric) in Maths, English and Physics/Natural Science, to get a full exemption and to choose Mathematics and not Maths Lit, otherwise they will not be accepted into engineering or science degrees at universities in South Africa.

17

Discuss some of these and how we can prevent them.

Air pollution has detrimental effects to the environment, animals, plants and humans.

Discuss the effects of air pollution in your classroom.

LET'S TALK ABOUT IT.

Smog

The international Montreal Protocol, to which South Africa is a signatory, has ensured that countries are reducing their usage of ozone-depleting substances like CFCs and HCFCs. The Montreal Protocol, which was signed in 1987, has ensured that countries will remain in Earth's atmosphere for up to 200 years.

Smog is produced when air pollutants such as nitrogen oxides from vehicle and industry emissions and volatile organic compounds (VOCs) emitted by vehicles react in the presence of sunlight.

In South Africa, smog can be seen as a brownish haze over cities. It reduces visibility, mostly in the mornings and late afternoons. If ground temperatures are lower than those of the upper atmospheric layers, the smog stays near the ground without spreading for a number of days.

Stratospheric ozone depletion

Unfortunately, the protective ozone layer is being thinned by chemicals known as ozone-depleting substances, which result from human activities. These include CFCs (chlorofluorocarbons), halons, methyl chloroform, carbon tetrachloride, methyl bromide and hydrochlorofluorocarbons. Until recent years, CFCs were widely used in aerosol cans, refrigerators, fire extinguishers and air-conditioning units.

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16

Acid rain or deposition is formed when sulphur dioxide and nitrogen oxides are released into the atmosphere. When these gases come into contact with water vapour and sunlight, they form sulphuric acid and nitric acid. This makes rain more acidic. The pH range of normal rain is already slightly acidic – between 5 and 7. Rain that falls below 5 on the pH scale is usually considered acid rain. All types of precipitation can be acidic – so, it is possible to get acid snow and acid hail. When acid precipitation falls to Earth's surface, it soaks into the ground and increases the soil's acidity.

Human health can be severely affected by acid rain. Not only can it increase the acidity of drinking water, but high concentrations of toxic metals such as lead, copper and aluminium can also get into drinking water.

Acid rain accelerates the erosion of stones such as sandstone, limestone and marble. Buildings and monuments made of these materials are damaged. Plant life is negatively affected by acid rain or acid deposition. Trees and forests have been known to die but more commonly, it damages leaves and weakens plants.

Aquatic animals (animals living in water) are especially sensitive to pH change caused by acid rain. The death rate is high when the watery environment becomes too acidic to support normal life processes.

The spreading of acid air pollution depends on the strength and direction of the wind. High factory chimneys are often responsible for acid rain in areas far away from the pollutant source. Pollutants from South Africa can travel as far as Mozambique, Swaziland, Lesotho and beyond.

ACID RAIN

9

Power stations that produce energy by the burning of fossil fuels such as coal, gas and oil also contribute to air pollution. Most of South Africa's electricity comes from the combustion of coal. The emissions produced include sulphur dioxide, carbon monoxide, various nitrogen oxides (NOx), mercury (Hg) and tiny particles, such as ash.

Industrial plants such as brickworks, steelworks, plants converting coal into oil, cement manufacturers are among those that can produce harmful pollutants.

Combustion (burning) of substances that contain hydrogen and carbon emits carbon dioxide. Industrial processes that involve burning coal, oil or other fuels can thus cause serious air pollution.

SOURCES OF AIR POLLUTION

24

Discuss how to calculate the Air Quality Index (AQI) and the SAAQI app.

What information can you find using the SAAQI app and what do the five bands/colours indicate?

Discuss how to use the app to identify and understand the meaning of the values.

LET'S TALK ABOUT IT.

HOW IS THE AIR QUALITY INDEX CALCULATED?

The AQI is calculated from six pollutant criteria (particulates PM10 and PM2.5, CO, SO2 and NO2) on a scale of 1 (for good air quality) to 10 (for hazardous air quality). Every five minutes, the data from air pollution sensors at the stations is transmitted to SAAQI's. Here, data is automatically quality-controlled to remove data that shouldn't be there. All data changes are noted in the database for further verification by data specialists. The data is averaged for the hour, and the pollutant levels are converted to an AQI score based on the bands in the AQI table. The highest AQI for that hour from all pollutants recorded is then reported as the AQI of the hour. This process is undertaken for data from each monitoring station, and the data is reported on the SAAQI's website and application.

The AQI:

- Provides guidance on what associated health effects might be of concern to the general population. It focuses on sensitive groups such as children, the elderly and people with medical conditions that can be exacerbated by poor air quality.
- Sends a clear and consistent message to the public on the state of air quality.
- Will be used for communicating air quality forecasting in the future developments of SAAQI's.

The index informs the public on how clean or polluted the air is and what associated health effects might be of concern. The higher the AQI, the greater the level of air pollution, and hence the greater the health concerns from exposure to poor quality air. The health messages are designed to help citizens take practical, protective actions to avoid or reduce exposure to pollution on days when unhealthy air quality is observed.

WHAT DO THE AIR QUALITY INDEX VALUES MEAN?

The table below shows how the data is translated to the AQI based on the colours of the circles. The index has five bands indicating "Low", "Moderate", "High", "Very High" and "Hazardous" levels of air pollution. For each of the pollutants, the bands are further divided into a ten-point scale to provide a gradation of air pollution levels.

- Low bands (AQI of 1 to 3)** indicate air pollution levels where it is unlikely that anyone will suffer any adverse effects from short-term exposure to air pollution, including people with lung or heart conditions who may be more susceptible to the effects of air pollution. Where South African air quality standards are defined for different averaging periods (8 hours for ozone or 24 hours for PM10/PM2.5), the hourly equivalent thresholds are estimated using best practices and leaning on ensuring the protection of human health.
- Moderate bands (AQI of 4 to 5)** represent levels of air pollutants at which there are likely to be minor effects for susceptible people. However, the general public is likely not affected.
- High bands (AQI of 6 and 7)** are associated with significant effects in susceptible people. However, the general public is likely not affected.
- Very High bands (AQI of 8 and 9)** are levels of air pollution under which even healthy individuals may experience adverse effects from short-term exposure. Members of sensitive groups may experience more serious health effects.
- Hazardous bands (AQI of 10)** are those levels that may trigger health warnings of emergency conditions as all persons may likely be affected with serious health effects.

When the AQI is...	...Air pollution will be	Station will be reflected as this circle	Colour of circle
Low	Good		Green
Moderate	Moderate		Yellow
High	Unhealthy		Orange
Very High	Very Unhealthy		Red
Hazardous	Hazardous		Purple

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8

Air Quality

Information to help learners and teachers to have a better understanding of air and air pollution.

25

PART 2: AIR POLLUTION

WHAT IS AIR POLLUTION?

Air pollution is contamination of the air by any chemical or compound that changes the natural characteristics of the atmosphere. This includes harmful substances in the air that may negatively affect human, animal and plant life. The substances that cause air pollution are called pollutants. **Pollutants** that are released directly from sources are called **primary air pollutants**. Examples include carbon monoxide (CO) from vehicle exhausts and sulphur dioxide (SO2) from burning coal.

When primary pollutants react with each other and with other gases in the atmosphere, **secondary pollutants** like ground level ozone (O3) are formed. This is "bad ozone" found close to Earth's surface, and should not be confused with the "good ozone" that provides protection from the harmful ultraviolet radiation of the sun.

Air pollutants can be gases, like carbon monoxide, sulphur dioxide, oxides of nitrogen and chemical vapours, or very small particles, like dust, bacteria, viruses, plant materials, dead skin cells or pieces of hair.

WHAT CAUSES AIR POLLUTION?

Air pollution is caused by natural processes and human activities. Natural events that result in air pollution include volcanic eruptions and wildfires, which release particles and gases into the air. Weather conditions like wind and rain quickly disperse these pollutants and maintain the atmosphere's natural balance.

In modern times, population growth, urbanisation and industrialisation are causing more pollution than natural air cleaners can manage. Human activities that contribute to air pollution are burning/fires, industrial emissions (especially from burning fossil fuels), vehicle emissions, waste incineration and combustion on mine dumps.

8

25

South Africa has standards for major pollutants such as sulphur dioxide, carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM) and benzene. If the levels of pollution are higher than the levels set in the standards, the air is considered to be unsafe. This means that the pollution level poses a health risk.

To differentiate between air that is harmful to health and well-being and that which is not, the government has also set ambient air quality standards (ambient air is basically outdoor air). These are used to measure whether the air is safe for human health.

Ambient air quality standards

These sources require an atmospheric emission licence before they can operate. For these sources, the government sets limits on the amount of emissions each source is allowed to release into the atmosphere. These are called emission standards and they are specific to each pollutant and source. There are different emission standards, for different industries. By law, it is an offence for a source to emit more than this emission limit. The Environmental Management Inspectors (Green Scorpions) from the Department of Environmental Affairs and other authorities conduct compliance and monitoring exercises to ensure that emission standards are met.

Emission standards

SETTING AIR QUALITY STANDARDS

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Contents

PART 1: The Earth's Atmosphere	3
The layers of the Earth's atmosphere	4
What are the common gases in the air we breathe?	5
PART 2: Air Pollution	8
What is air pollution?	8
What causes air pollution?	8
Sources of air pollution	9
PART 3: Pollution Problems	12
Health related issues	12
Carbon monoxide and carbon dioxide	12
Particles in the air	14
Other pollutants	14
Environmental effects	15
Acid rain	16
Stratospheric ozone depletion	17
Smog	17
PART 4: What Can Be Done?	18
What is the government doing to address air pollution?	18
Setting air quality standards	19
What can be done to reduce air pollution?	20
PART 5: Air Quality Monitoring	22
How does air pollution information reach the public?	23
How is the air quality index calculated?	24
What do the air quality index values mean?	25
How do I protect my health?	26
Where can I find the AQI?	27
PART 6: National Priority Areas	28
CONTACT INFORMATION	30

CONTACT INFORMATION

Other pollutants

Exposure to other pollutants such as sulphur dioxide, ground level ozone, nitrogen oxides, mercury, lead (Pb), asbestos and benzene (C6H6) contributes to most respiratory related problems as explained above.

Other pollutants

Dust particles originate from many different sources, such as pets, plant matter, degraded skin cells, cigarettes and mines. Dust particles are (very) consistently arranged in particles of 0.0001 mm in size (particles in tobacco smoke) to 0.1 mm (cement, dust, pollen). Chunky dust with a diameter greater than 100 µm (0.1 mm) can remain airborne for only a short time before falling to the ground. Particles smaller than 5 µm can stay in the air for days to weeks before they fall to the ground; there are two sizes of particulate matter of concern: M10 (particles of 10 µm and smaller) and PM2.5 (particles of 2.5 µm and smaller).

As we breathe in tiny particles, they can remain in the lungs and cause tissue damage. Allergies, asthma, bronchitis, persistent coughs and even lung cancer can result. Many dust particles carry poisonous materials (for example, lead, cadmium or nitrate) that are harmful to health.

Particles, called aerosols or particulate matter (PM), consist of different materials, such as dust, ash, soot, sea spray, minute sand particles and pollen from plants. These particles in the air are needed for the process of forming clouds, and reflect a significant amount of sunlight. Though some particles in the air are natural, many of them can cause environmental problems and negatively affect human health.

Particles in the air

IT'S TALK ABOUT IT.

Discuss the different causes of air pollution in your classroom.

In addition to man-made sources, large quantities of air pollutants are released from natural sources.

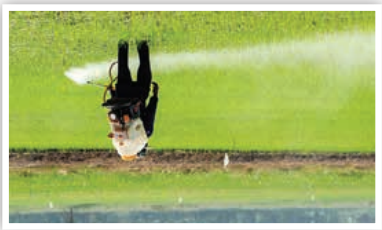
Can you list the different causes that are natural versus man-made?

Volcanic eruptions produce gases such as carbon dioxide, sulphur dioxide and hydrogen fluoride (HF), as well as ash particles. Eruptions release the pollutants high into the atmosphere, where they can travel long distances and cause disruptions. **Wind erosion:** Dust particles are released from soil surfaces in windy conditions, especially where there are few plants and dry soil, e.g. in deserts.

divided and forest fires are common man-made and natural sources of air pollution. They spread quickly and have a large impact on the atmosphere's chemistry, emitting pollutants such as carbon monoxide, sulphur oxides, nitrogen oxides, and tiny particles into the atmosphere. Significant quantities of pollutants are also released from natural sources such as animals, marshes, pollen and soil.

from natural sources.

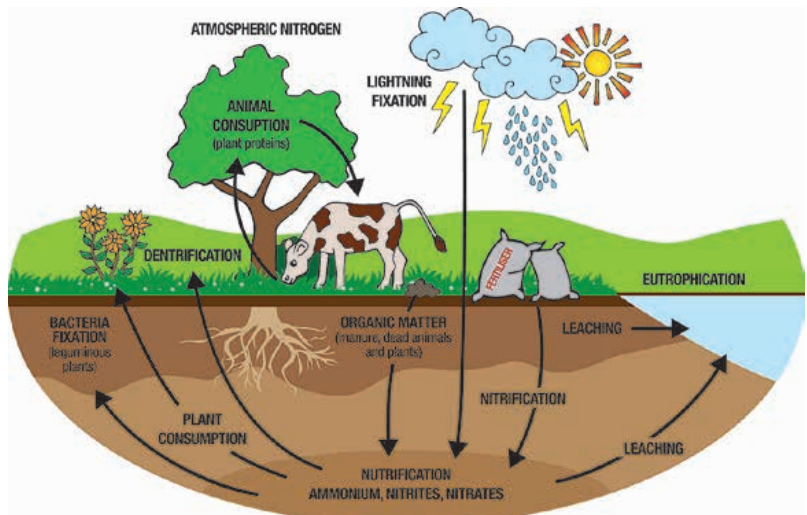
Refuse burning is very dangerous, as refuse is a mixture of many different materials. For example, if you burn plastics or tyres, dangerous substances are given off that can harm the environment.



The carbon is then passed along the food chain and returned back to the atmosphere as carbon dioxide when people and animals breathe it out. Most of the remaining carbon is returned to the atmosphere when plants, animals and people die and decompose. This is referred to as the **carbon cycle**.

Nitrogen is the most abundant gas in the lower atmosphere and is needed by living organisms. But how does it move from the air into the organisms?

Since nitrogen is a gas, it first needs to be converted into a chemical form that plants can use as nutrients. Nitrogen is absorbed into the soil, where bacteria turn it into ammonia and ammonium, which the plants use to build proteins and other essential chemicals. When animals eat the plants, the nitrogen is transferred to them. Nitrogen returns to the soil in the urine and faeces from animals, or when dead plants and animals decompose. In the soil, bacteria convert compounds back into ammonia again. Some bacteria also return nitrates in the soil back into the air as nitrogen gas. This is called the **nitrogen cycle**.



Nitrogen Cycle



Wise environmental management and lifestyle choices can lead to cleaner air, which has direct health benefits for everyone. Here are some ideas of what you can do, but try to think of other ways, too.

You have seen that air pollution is a vast problem with many different causes and effects. One person's efforts might not make much difference in reducing the major sources of pollution, but collective efforts by whole communities can make a difference.

Individuals:

- Cleaner, more fuel-efficient vehicles
- Changing to alternative fuels
- Scrapping of old, polluting vehicles
- Improved vehicle maintenance

Transportation:

- Switching to cleaner fuels, such as gas, for cooking and heating
- Using solar energy, e.g. solar water heaters

Household:

- Control of fugitive dust emissions by watering or chemical suppression
- Vegetation on mine dumps

Mining:

- Setting stricter emission limits for stacks
- Switching to renewable energy
- Finding alternatives to fuel combustion
- Pollution control equipment on stacks

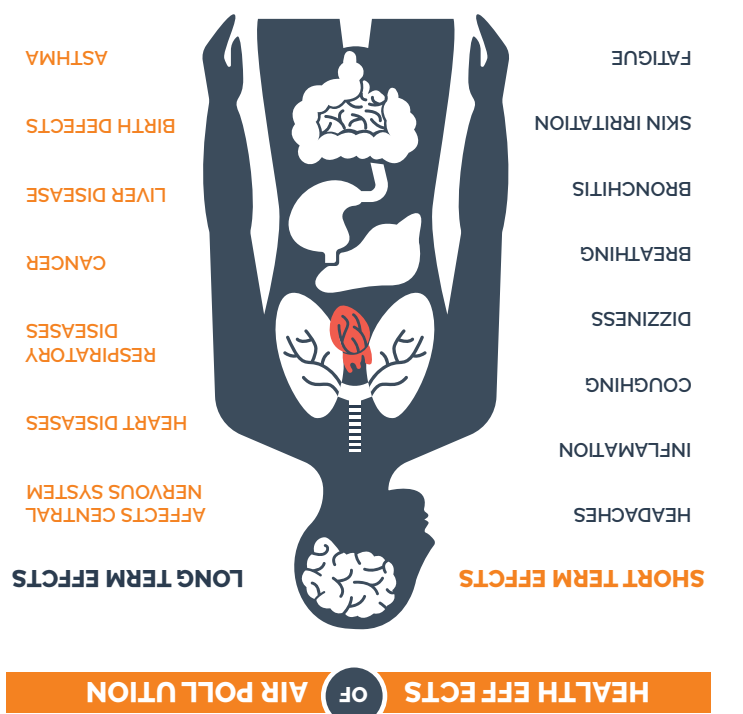
Power stations / electricity generation

- Pollution control equipment on stacks (industrial chimneys)
- Switching to alternative fuels (for example using gas instead of coal)
- Changing to cleaner technology
- Setting stricter emission limits for stacks

Industry:

WHAT CAN BE DONE TO REDUCE AIR POLLUTION?

Carbon dioxide is essential for the existence of all ecosystems. It is a reactant in the process of photosynthesis, where it is built into glucose molecules first, and into other compounds subsequently. Carbon dioxide is the most significant greenhouse gas. It is a major contributor to the insulating layer of the atmosphere which maintains Earth's temperature. Though the greenhouse effect in itself is not a bad thing, it becomes a problem when carbon dioxide levels in the atmosphere become too high and increase the insulating effects of the atmosphere, raising average global temperatures.



HEALTH EFFECTS OF AIR POLLUTION

Carbon dioxide is a natural part of the atmosphere. Like carbon monoxide, it has no colour, but it has a slightly acidic, sour flavour and smell. It doesn't burn and is heavier than air. In high concentrations, carbon dioxide is poisonous and can cause death.

Carbon monoxide has devastating effects on the respiratory system. Haemoglobin is the molecule in red blood cells that is responsible for carrying oxygen to the rest of the body. However, carbon monoxide has a 210 times greater attraction to haemoglobin than oxygen, so when carbon monoxide occupies the haemoglobin, cells throughout the body become starved of oxygen. This leads to headaches, nausea, dizziness, lethargy and weakness, impaired vision and, in severe cases, coma and death. The most vulnerable people are unborn babies, elderly persons and those already suffering from heart and respiratory problems.

Carbon monoxide is a poisonous gas that is difficult to detect because it is odourless, colourless and tasteless, and is not an irritant. The highest concentration of carbon monoxide exists in areas close to the earth's surface. It is found in streets full of traffic, in closed garages, in stuffy rooms with burning coal and wood and in tobacco smoke.

Carbon monoxide and carbon dioxide

Exposure to pollution may cause various health problems. It can make your nose burn, irritate your throat and eyes and make breathing difficult. Tiny particles of dust and smoke often get deep into a person's lungs and cause problems like wheezing and coughing. Other health problems include asthma, cancer, heart diseases, skin irritations, headaches, dizziness, fatigue, nervous disorders and birth defects.

HEALTH-RELATED ISSUES

Air pollution causes health-related problems and negatively affects the environment. The main problems related to air pollution are acid rain, poisonous particles and gases in the air, climate change, smog and the depletion of ozone.

PART 3: POLLUTION PROBLEMS

Troposphere: This is the first layer of the atmosphere where people, plants and animals live. It consists of the gases that we breathe every day. This part of the atmosphere is warmer than the stratosphere and mesosphere because the air is heated by the surface of the earth, which absorbs the sun's energy.

Stratosphere: Aeroplanes fly in this layer above the troposphere and the ozone layer is found here. The ozone layer is important, as it absorbs harmful ultraviolet (UV) rays from the sun, protecting life (including humans) in the troposphere.

Mesosphere: This layer extends upward above the stratosphere. It is the coldest part of our atmosphere, with temperatures in this layer reaching as low as -90°C.

Thermosphere: Though the air is incredibly thin in this layer of the atmosphere, the temperatures are very high since many of the sun's high-energy X-rays and UV rays are absorbed in this layer.

WHAT ARE THE COMMON GASES IN THE AIR WE BREATHE?

Air is essential to all life on Earth. The air that animals and people breathe is found in the troposphere. The air comprises mostly of nitrogen (N₂) and oxygen (O₂), along with water vapour/droplets, fine particles and a small amount of other gases, such as carbon dioxide (CO₂), nitrous oxide (N₂O), methane (CH₄), ammonia (NH₃) and argon (Ar).

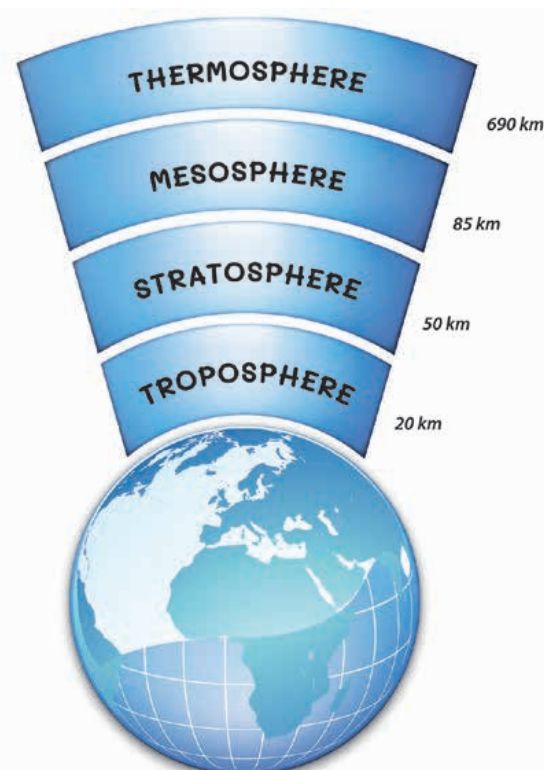
Atmospheric gases	Volume %
Nitrogen	78.084
Oxygen	20.946
Argon	0.930
Carbon dioxide	0.034
Others	0.006

When people and animals breathe, they inhale oxygen and exhale carbon dioxide. During a process called photosynthesis, plants take carbon dioxide from the air and use it, along with water and the sun's energy, to produce glucose as food and release oxygen back into the air. A lot of the carbon from the carbon dioxide becomes part of the plant.

PART 1: THE EARTH'S ATMOSPHERE

THE LAYERS OF THE EARTH'S ATMOSPHERE

Earth's atmosphere consists of several layers: the troposphere, stratosphere, mesosphere and thermosphere.



Different layers of the atmosphere



Discuss in your classroom or small group on how industry, power stations, mines, and farming communities can reduce their emissions that contribute to overall air pollution.

LET'S TALK ABOUT IT.

Environmental Forums (committees) have been formed in the national priority areas and other "hot spots", so that air quality issues can be discussed, problems can be identified and solutions can be found. These Environmental Forums are quite successful, because people, at least in those areas, are now aware of air pollution issues.

The DEA recognises the importance of public awareness and education of communities on air quality issues, so that everyone can take a role in looking after the environment.

Protect trees in your area, and plant indigenous trees where possible. These trees will help to filter impurities from the air and balance the levels of oxygen and carbon dioxide.

Dispose of rubbish wisely and avoid burning it. Burning plastics can be especially harmful, because they emit toxic chemicals.

Pollution with the vehicle's driver. Many buses, taxis, trucks and cars emit clouds of diesel pollution the air in our towns and cities. Where possible, politely discuss the health consequences of this

emitted, how harmful they are and how long they will persist. Investigate strange smells in your area. Don't just accept that the odour or particles in the air come from a nearby factory or dump. Find out why these pollutants are being

investigate strange smells in your area. Don't just accept that the odour or particles in the air come from a nearby factory or dump. Find out why these pollutants are being emitted, how harmful they are and how long they will persist.

If you live in a house with smokers, ensure that the rooms are well ventilated or, better still, ask people to smoke outside. Similarly, houses which use gas heaters, fuel stoves or open fires should also be well-ventilated to allow stale, pollutant-carrying air to escape.

PART 6: NATIONAL PRIORITY AREAS

