

Advancing Climate Change Knowledge Within Namibia Through a Virtual Exhibition: Supplemental Material

Report Writtern By
Robert Doyle
Braeden Fruchtman
Sam Griffiths
Nicholas Moy

Project Advised by
Prof Crystal Brown, WPI
Prof Amanda Whitman, WPI

Sponsored by
EduVentures Trust

This report represents the work of WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. For more information about the projects program at WPI, please see

<http://www.wpi.edu/academics/ugradstudies/project-learning.html>

Authorship

Section	Author	Editor
Title	Nicholas Moy	Edited by all
Abstract	Sam Griffiths	Edited by all
Acknowledgments	Braeden Fruchtman	Edited by all
Background	Drafted by section	-----
Environmental Health and Education in Namibia	Robert Doyle	Edited by all
Educational Implications	Robert Doyle	Edited by all
Climate Change Resilience	Robert Doyle	Edited by all
Virtual and Visual Environmental Education	Robert Doyle	Edited by all
Methods	Drafted by section	-----
Updating the Current Exhibition	Sam Griffiths	
Updating the Climate Change Booklet	Robert Doyle	Edited by all
Implementing the Virtual Climate Change Exhibit	Sam Griffiths	Edited by all
Findings and results	Drafted by section	-----
Original Exhibit Contained Abundant and Messy Information	Sam Griffiths	Edited by all
Original Exhibition was outdated	Sam Griffiths & Braeden Fruchtman	Edited by all
Climate Change Data not Accessible	Robert Doyle	Edited by all
Initiatives in Namibia to Educate and Mitigate the Effects of Climate Change	Robert Doyle	Edited by all
The Finalized Panel Designs	Nicholas Moy	Edited by all

Table Of Contents

Appendix A: Skeleton Draft of the Booklet	4
Appendix B: Unstructured Interview Topics	17
Appendix C: Guide for Virtual Implementation	17

Appendix A: Skeleton Draft of the Booklet

Foreword	<h3>Foreword</h3> <p>Climate change has become a household term around the world. It is the change in global or regional climate patterns typically due to the increased levels of greenhouse gases in the atmosphere produced by fossil fuels. Major world summits have been held to discuss Climate Change, and Namibia has joined the international collaboration. Namibia has been experiencing climate change first hand with extreme weather patterns seen in more damaging flood and drought seasons. This has left many citizens in great despair as the severe weather changes have disturbed agricultural production, which about 70% of Namibia depends on for their livelihood. This also piques our vulnerability as a nation because our country relies heavily on natural resources for a stable economy.</p> <p>One cannot forget to mention the ripple effects of significant problems that follow Climate Change, such as hunger, poverty, malnutrition, unemployment, and even, in some cases, death.</p> <p>Namibia has developed methods to mitigate and adapt to climate change, including our involvement in the Climate Promise and the sustainable development goals. Namibia has promised to reduce all carbon emissions by 91% by 2030 and has joined the rest of the world in the Paris Agreement to solve the climate change crisis.</p> <p>This book allows every Namibian citizen to have access to information about climate change. I encourage everyone to actively contribute to reducing their carbon footprint in any way possible.</p> <p>Emma's Section when we receive it will be placed here along with a picture of Emma above it</p>
-----------------	---

Table of Contents

Table of Contents

Acknowledgement	2	Acknowledgement
Foreword	3	This presentation was made possible through the funding of _____
1. Changing Climate, Changing Namibia	4	
2. Our Blue Planet	5	Additional support is provided by the Gesellschaft für Internationale Zusammenarbeit (GIZ), Museum Association of Namibia (MAN) and University of Namibia (UNAM).
3. Causes of Climate Change	6	
4. Carbon Footprint	7	
5. Extreme Weather	8	
6. Role of the Ocean	9	
7. Impact of Climate Change on Biodiversity	10	
8. Reducing our Carbon Footprint	11	
9. Mitigating Climate Change - The Green City	12	
10. Coping with Climate Challenge	13	
11. Meeting the Climate Challenge	14	
12. Hands on Taking Action	15	
13. My Pledge	16	
14. Activity & Notes Pages	17	



Changing Climate Changing Namibia

Namibia's Climate, Population Distribution & Natural Resource Dependency

Over the past century, Earth's Climate has risen at an alarming rate and is expected to continue to rise over the next century. This occurrence, known as climate change, negatively impacts the environment, threatening all life on Earth, including Namibia. The challenges facing Namibia and the world require changing lifestyles and actions. The changing climate affects the economy and natural resources, causing significant damage to Namibia. Namibia needs a population with a climate and environmental literacy to maintain a habitable atmosphere. Climate literacy allows individuals to improve their quality of life due to their understanding of human and natural factors that affect the climate (What is Climate Science Literacy?, n.d.).

Namibia's Vulnerability to Climate Change

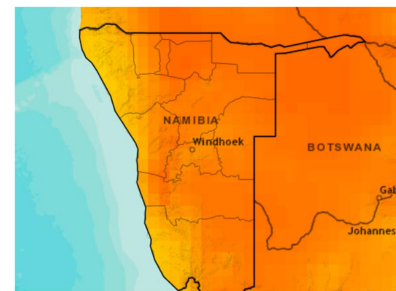
Namibia is one of the most vulnerable countries to climate change due to its arid environment. It is at high risk of flooding, wildfires, and droughts, affecting every region of the country. With climate change worsening, these events may become more common, causing more damage to Namibia.

Aim of Booklet

This booklet aims to provide information about climate change and its effects in Namibia. This book should support and accompany the Climate Change exhibition and can help guide the exhibition.

It also includes various activities that allow for a better understanding of climate change, along with demonstrating ways individuals can help Namibia reduce the impact of climate change and support global efforts to combat the causes.

Observed Climatology of Max-Temperature 1991-2020
Namibia



Activity:

Namibia has a hot and arid climate. Where on the map above have the hottest temperatures in Namibia been seen? Could you imagine what would happen if the temperature kept getting hotter?

My Home the Blue Planet

No other planet can sustain life

Earth is the only planet in our solar system capable of sustaining life. Due to the Earth's size, its perfect distance from the sun, and its chemical composition, it is also the only planet in the system that contains water in its liquid form. 71% of the Earth's surface is covered in water, hence the fact that it is called the Blue Planet.

The Spaceship Earth Concept

The term 'Spaceship Earth' has been used to describe the idea that all people need to work together to keep the planet functioning correctly. It is used to express concern over our limited resources and encourages people to be mindful of their usage. If we are not conscious of our resources, we will reach a point of no return, and it will be too late to save the planet.

As the population continues to grow, resources become more and more scarce. The scarcity and depletion of these resources are only exacerbated by increased greenhouse gas emissions and consumption trends. As the quality of life continues to decrease worldwide, the time is now to consider what can be done to save the planet and keep the spaceship functioning. On a real ship, a captain could dock and resupply. On Spaceship Earth, we do not have that luxury, so the question remains: What will we do if our ship runs out of resources?

The Earth's Atmosphere

The key factor to maintaining the conditions here on Earth is the atmosphere. Composed of multiple layers of gasses, the atmosphere protects against meteorites and UV radiation. As meteorites attempt to enter the Earth's atmosphere, they are burnt up and destroyed before they can reach the surface. As for UV radiation, the atmosphere's ozone layer reflects it outwards, preventing most of it from reaching us on the surface. Ozone is composed of 3 oxygen molecules, and the layer resides in the stratosphere.



Activity:

What do you do to conserve resources such as water and food? Earth has limited resources and we all need to take action to save our home planet.

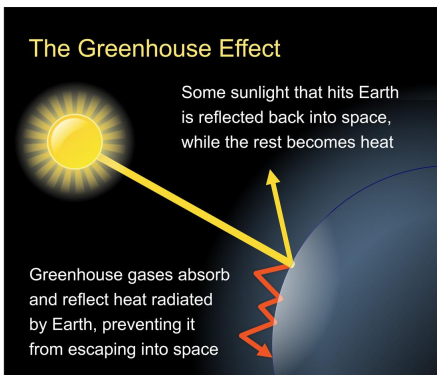
Cause of Climate Change

Cause of Climate Change

Climate change is a natural phenomenon but is increased by releasing greenhouse gases into the atmosphere. Some greenhouse gases have been in the atmosphere for millions of years, and the climate has changed and fluctuated. One of the most common greenhouse gases is carbon dioxide, which is released by a variety of animals and humans too.

Human Induced Climate Change

Human activities contribute a significant amount of greenhouse gases into the environment. Burning fossil fuels, Cattle farming, use of pesticides, etc, are all human actions that result in the release of greenhouse gasses into the atmosphere. Greenhouse gases can trap heat in the atmosphere, resulting in the greenhouse effect. (The Causes of Climate Change, n.d.)



Who are the main contributors to climate change?

Due to different levels of industrial development and consumption patterns, countries and individuals contribute differently to global warming and climate change. Namibia contributes significantly less than Industrialized and developed nations such as the USA, Europe, and China. The whole of Africa only makes 0.5%-1% of the impact of America. Though any contribution to climate change is bad

Page 7: Carbon Footprint

CARBON FOOTPRINT

No matter how small the country's carbon footprint, we are all affected by climate, and as such, all countries should implement measures to reduce and cope with the changing climate. Namibia's climate is changing; therefore, we should change Namibia and prepare to cope with the predicted impacts.

What is a Carbon Footprint?

This is the amount of greenhouse gasses, such as carbon dioxide, released into the atmosphere due to our actions. This is measured at individual, community, regional or national levels. Therefore, some people have a bigger footprint (contribution to CO₂).

ACTIVITY

Circle the letter that best answers the following questions, and then use the Scoring Instructions to calculate your "carbon footprint" – the effect your family has on the climate in terms of greenhouse gasses you produce measured in units of carbon dioxide.

- How do you get to school/work?
A. Walk or ride your bicycle C. Bus
B. Motorbike D. Car
- What kind of vehicle(s) do you/your parents drive?
A. None (Don't own a vehicle) C. Car
B. Motorbike only D. SUV, van, bus or truck
- How often does someone in your family fly in a plane?
A. Never flies C. 2 to 4 times per year
B. Once per year D. More than 4 times per year
- How often does your family eat out or order food at a restaurant?
A. Never C. Once per week
B. Once per Month D. Twice or more per week
- What kind of food does your family eat?
A. Home grown or raised C. Store bought only
B. Combination of store bought and home grown
- How many carbonated drinks (cool drink or fizzy) do you drink?
A. None C. 2 cans/bottles per day
B. 1 can/bottle per day D. 3 or more cans/bottles per day
- How often does your family do laundry?
A. Once per month C. Once per week
B. Twice per month D. Twice or more per week

8. Do you get newspapers or magazines at home?
A. Yes B. No

9. Do you turn the lights off when not needed?
A. Yes B. No

10. Do you turn off your computer, video games, or other electronics when you're not using them?
A. yes B. No

11. What source of energy do you use for cooking, lighting and heating your home?

- A. Solar C. Paraffin/candles
B. Wood D. Gas/electricity

12. Does anyone in your home own any of the following items? (Circle all that apply.)

- A. TV F. Dishwasher
B. Cell phone G. Refrigerator
C. DVD Player H. Microwave
D. Computer I. Heater
E. Washing machine J. Moterbike, Quad

SCORING INSTRUCTIONS

For questions 1 through 11, assign 1 point for each A answer, 2 points for each B, 3 points for each C and 4 points for each D. For question 12, assign 1 point for each item circled. Add the points together to determine your "carbon footprint."

13 – 20 Points: Green is your favorite colour.

Keep up the good work.

21 – 28 Points: Very good.


29 – 36 Points: Your efforts are appreciated.

36 – 43 Points: There's room for improvement.

44 – 46 Points: Look for ways to become

better friends with Mother Nature

A Note About Your Carbon Footprint As this worksheet shows, the more you consume, the greater your carbon footprint. Each time something is consumed, the earth's natural resources are used. By knowing your carbon footprint, you can understand how the earth is impacted and identify ways to protect natural resources.

			
<h1 style="text-align: center;">EXTREME WEATHER</h1>			
	Change in Precipitation	Temperature Changes	Change in Evaporation
	<p>Within Namibia, rainfall reductions are expected to be greatest in the northwest and central regions. Projections range from small increases of less than 30mm per year to severe decreases of 200mm per year compared to the current average. Rainfall and temperature in Namibia are sensitive to the El Nino-Southern Oscillation (ENSO) effect, and rainfall is below average during El Nino conditions.</p>	<p>By 2100, Namibia's average temperature in Namibia may increase itself, predictions for temperature increases by 2100 range from 2 to 6 C. Temperature increases are lower in the coastal regions than the inland regions</p>	<p>As temperature increases, so to will evaporation leading to a drier climate in Namibia. An increase in evaporation of about 5% is expected per degree of warming. With water quantities expected to decrease, Namibia will likely face an even greater water shortage. Rural populations within Namibia will feel these effects the greatest.</p>

Climate Change and the Ocean

Carbon Intake 25% Sea Level Rise: 1.3-1.6 by 2100

Temperatures Rise: 1.2-3.2 C by 2100

The oceans play a vital role in regulating the climate; they generate oxygen and absorb carbon dioxide from the atmosphere while providing essential goods and services for sustaining life on Earth. As climate changes, so do our oceans, leading to temperature and sea level rise. As both rise, oceans lose their ability to capture carbon, further accelerating climate change and putting marine ecosystems and coastal communities at risk.

The Benguela current brings cold, nutrient-rich water from the Antarctic along the coast of Namibia. With climate change, this current is expected to change significantly with rising sea temperatures. These rising temperatures may cause an El Nino effect, bringing heavy and damaging rainfall and wind to the region.

Economic productivity

Fishing industries contribute 3% of GDP. Damages to this fragile industry could mean direct economic hardship for over 10,000 Namibians. With rising sea temperatures, the Benguela Current is already losing its fish population and will only continue until climate change is mitigated.

Three possible scenarios that could result from climate change along the Namibian coastal region:

1. Reduction in upwelling intensity
2. Increase in average summer wind stress
3. Increase in the frequency and severity of Banguela El Nino events

Rising Sea Levels

Due to the increased temperatures, the earth's ice is melting into the sea at an increased rate. Global sea levels are expected to rise 1.3-1.6m by 2100 causing severe damage to Namibian coastal cities like Walvis Bay as well as damaging the fragile ecosystems that make up the coast.

Impacts of Climate Change on Biodiversity

Due to the reduction and change in rainfall, biodiversity will be lost due to vegetation and specific agricultural practices being unable to function. It is expected that plant species will experience a shift in distribution, growth and productivity. Changes in rainfall patterns will worsen the desertification process causing increased land degradation. Eventually, ecosystems will be unable to maintain functionality and support life at all.

Rainfall Changes
Decrease in
4% Rainfall every
year

The change in rainfall patterns and weather is one of the biggest challenges affecting Namibia. As an arid environment, the shift in rainfall can cause more devastation as regions are projected to receive less rainy days. On average, Namibia receives 41 rainy days a year, which is more than 0.1 mm of rainfall in one day. It is expected that Namibians annual rainfall will decrease by 4%.

Shift in Vegetation
45 Million Hectares
affected by bush
encroachment

The excessive expansion of bush, trees and grasses is known as bush encroachment and it is devastating to agriculture and ecosystems throughout Namibia. In the past 10 years, agricultural productivity has declined by two-thirds due to bush encroachment, harming both commercial and communal farms. It is estimated that 45 million hectares of land are at risk to bush encroachment.

**Unproductive
Economy**

**Major Reduction in
Subsistence Farming**

The shift in vegetation will affect the availability of farmland and productivity in the agriculture sector. 70% of Namibians rely on agriculture, the majority in the subsistence sector which has a high dependence on rainfall with a low crop yield. Namibia is projected to have a major decrease in subsistence farming, which would be incredibly damaging to the livelihood of the majority of Namibians. Due to climate change, biodiversity will be lost which would cost Namibia billions of dollars.

Green City Concept

Why Green City?

Today, more than half of the world's population lives in cities. As the urban population grows and the effects of climate change worsen, our cities must adapt. Cities need to accelerate their transition to a cleaner, healthier, and more economically viable future through improvements in efficiency, investments in renewable technology, and regulation reform. These large communities provide both challenges and opportunities for environmentally-conscious developers, and there are distinct advantages to further defining and working towards the goals of sustainable cities.

What is it?

Concerns about urbanization gave birth to the idea of green cities. Best described as a loose association of cities focused on sustainability, the emerging "green cities movement" encompasses thousands of urban areas around the world, all striving to lessen their environmental impacts by reducing waste, expanding recycling, lowering emissions, increasing housing density while expanding open space, and encouraging the development of sustainable local businesses.

Is it relevant to Namibia?

Urbanization places more pressure on the environment as more land is cleared to create space for people. As of 2021, 53% of Namibia's population lives in urban areas, which is expected to grow yearly by around 1%. This will likely come with consequences since the government does not have the resources to make land available for urban development.

As the population continues to grow without enough resources, more and more informal settlements will form. Without proper help, these settlements will grow without adequate access to electricity, water, sewage management, and more.

Activity

Using what you have learned about green cities and sustainable development, what ideas would you have for making your city a green city?

Coping with Climate Challenge

Adapting to the Impacts of Climate Change

In Namibia, climate change dramatically affects agriculture due to 70% of the population's dependence on agriculture as a daily income. The continued decrease in water availability and rainfall will cause more land degradation and harvest losses. New agricultural practices and methods must be adopted to prevent these issues from worsening.

Other than reducing our emission of greenhouse gasses by developing new technologies in green cities, humans need to develop new strategies to cope with the current impacts of climate change. The current emission will still have implications throughout the country, such as rising sea levels and droughts. People must work together to become educated on climate change, putting differences aside to help save the planet we all share.

Differing from mitigation which is the action of limiting greenhouse gasses, climate change adaptation is the process of adapting to the current effects or predicted effects of climate change. It is crucial to adapt and find innovative ways to survive the impacts of climate change because many of the effects are inevitable. We can reduce the loss of livestock and crops by finding new farming techniques or ideas.

Examples of Adaptation Projects

- Installing protective and/or resilient technologies and materials in properties that are prone to flooding
- Changing to drought-tolerant crop varieties
- Rainwater storage to deal with more frequent flooding and heavier rainfall
- Changing to water-permeable pavements, adding water-buffering vegetation, adding underground storage tanks, subsidizing household rain barrels
- Reducing paved areas to deal with rainwater and heat
- Requiring waterfront properties to have higher foundations
- Raising pumps at wastewater treatment plants
- Surveying local vulnerabilities, raising public awareness, and making climate change-specific planning tools like future flood maps
- Incentivizing lighter-colored roofs to reduce the heat island effect
- Installing devices to prevent seawater from back flowing into storm drains
- Installing better flood defenses, such as sea walls, and increased pumping capacity
- Raising street levels to prevent flooding
- Protecting the water supply from contamination

Activity

The difference between mitigation and adaptation.
Link the word to the picture. The aim of the game is to make sure you can differentiate between climate change mitigation and adaptation.

Mitigation



Adaptation

Meeting the Climate Challenges

To meet the challenges of climate change, Namibia needs to develop technologies and adaptation strategies. Because there is so much at stake with climate change risk, there is also a great need for teamwork and cooperation. People of all professions throughout Namibia have a role to play when meeting these challenges. Farmers, teachers, engineers, and more all have a contribution to make to address the needs of climate change, but that does not mean that they are the only ones at risk. Everyone around the globe has been and will be affected by climate change, meaning that everyone has something to contribute and can cooperate.

Roles of different career options and professions in combating climate change

Nurses/Doctors

- Develop new technologies for diseases related to climate change.
- Promote walking and cycling as part of healthy living, and reduce fumes from cars.
- Conduct health and well-being awareness campaigns in communities.

Farmers

- Diversified farming (mixed farming) to avoid a total loss due to unpredictable weather.
- Farm with adaptive breeds to ensure maximum output.
- Develop new farming techniques which can withstand variability

Politicians

- Advocate for laws and policies that promote sustainable living
- Educate the nation about climate change.
- Sign petitions for climate change mitigation.

Business executives

- Turn your offices into green offices.
- Use renewable energies for your businesses operational functions.
- Be committed to your corporate responsibility and invest in environmental friendly projects.

Architect

- Design green buildings.
- Design cities to avoid urban sprawls.
- Design buildings to avoid heat islands in cities.



Namibia has fought the war of liberation and won. However, the war against climate change is even fiercer. This war does not discriminate against skin color, race, religion, or recognise borders.

Namibia has, therefore, internationally ratified treaties that fight to reduce and adapt against climate change. These treaties and accords include the Paris Climate Agreement, UN Development Program Climate Promise, UN Framework Convention on Climate Change.

In addition to the Climate Change treaties and conventions, in 2015, the United Nations created the Standard Development Goals (SDGs), a set of goals that recognize action in 17 areas that could be improved upon worldwide. Each goal has specific targets to be achieved by 2030. Namibia, like the rest of the world, has adopted these goals.

At both the regional and national levels, Namibia has taken significant steps in legislation and policies to fight against climate change. National Policy and Legislation for the protection of biological diversity and to reduce climate change effects are listed below:

1. Nationally Determined Contribution for Namibia (2021)
2. Second Biodiversity Strategy and Action Plan (2013)
3. Environmental Management Act (2007)
4. National Land Use Planning Policy (2002)
5. Namibia Drought Policy and Strategy (1997)
6. National Agriculture Policy (1995)

The foundation of these policies comes from Vision 2030 which aims to improve the quality of life in Namibia and raise its level to its developed counterparts.

We each have to think beyond our direct observations and lives. We live in an interconnected world, and our futures are linked. We need to explore and establish dynamic partnerships that explicitly expand our boundaries, particularly at the national and local levels, where the necessary flexibility allows us to address locally relevant issues. No one can do it alone, so leaving no one behind is the correct motto for our efforts.



Appendix B: Unstructured Interview Topics

Topic of Discussion	Sub Topics
Very Wordy Sections	<ul style="list-style-type: none">- What can stay and what can be removed- Bullet points instead of sentences
Out of Data Information	N/A
Purpose of Panels	<ul style="list-style-type: none">- Purpose of information of each panel- Purpose of paragraphs and graphs
Flow of Exhibition	<ul style="list-style-type: none">- How Does each panel flow ?- What comes after each panel ?

Appendix C: Guide for Virtual Implementation

Below is a step-by-step guide to implementing the climate change exhibition on a virtual platform using the software provided by Ikonospace. This guide can be put into place once the budget has been amended and the invoice has been paid. The WPI team can provide remote assistance if necessary in the process. Ikonospace customer service is also available for any technical issues in the implementation process and can be contacted via email at info@ikonospace.com.

1. Create an Ikonospace account at <https://art.kunstmatrix.com/en/user/register>
2. Purchase template through Ikonospace email provided above
3. Download template purchased through Ikonospace
 - a. Template should be available on account after purchase and easily accessed
4. Obtain all Climate Change Exhibition panels via flash drive left by WPI team
5. Plug the flash drive into the computer, and locate the PDF files of the panels in the folder labeled "Climate Change Exhibition Panels"

6. Upload the panels to Ikonospace template, ensuring the resolution size is lowered to the maximum allowable amount pixels
 - a. If any issues arise here, please contact and create zoom meeting with ikonospace, can help make sure the dimensions are correct when uploading
 - b. If Audio file is available, click audio tab on the top and insert the audio for the specific panel
7. Enter the virtual template space
8. Click on the large check mark on the wall and click add image. Choose the select panel that you would like to have uploaded to the section of wall and click confirm
 - a. Repeat this step for all 12 panels, spacing them at your own will around the virtual space allowing each panel to be in its own section
 - b. Click on the corner of the image to resize, allowing for largest and most readable size possible
9. Pay Ikonospace to publish fee of 10 Euros, then publish the virtual exhibit to the internet for access to all
 - a. 10 Euros will need to be paid every month to keep the website published and running, can set up a payment that goes through automatically through the help of Ikonospace
10. Embed the Virtual exhibit to the current EduVentures website using the embed code provided by Ikonospace when publishing a virtual platform
 - a. Use the original web developer for assistance
 - b. The embed code can be copied and pasted directly onto the EduVentures website and will run with full functionality