ARUP

engineers without borders uk
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WATER FOR THE WORLD

Water Supply & the Developing World Module

A Collaboration between
Engineers Without Borders UK
and Arup Cause

TABLE OF CONTENTS

Below there is a list of relevant documents contained in this pack. Please check the end recipient and if needed distribute the material to the appropriate recipient at the right time. If the session is being run from a person external to the school please ensure that the teacher(s) responsible receive the appropriate information in time.

SESSION SUMMARY & REQUIREMENTS

Session Title

Water Supply and the Developing World

Description and Aims:

Water for the World (WftW) is an interactive classroom session for pupils between the ages of 11 to 18, that aims to stimulate thought on global water sustainability, thus adding an important element to the school curriculum. WftW aims to stimulate critical thinking and encourage pupils to think about global water sustainability via presentations, quizzes, games and through hands-on experience. It highlights to young people issues such as global water scarcity the challenges people face when sourcing water and maintaining a water supply in developing countries and the role of the engineers in solving these problems.

A key part of each 90-minute WftW session is a hands-on workshop that demonstrates the challenges those in developing countries face to obtain safe drinking water. Participants learn through vivid experience that without technical knowledge, dependable communications and access to other resources, creating and sustaining a healthy living environment is very difficult. The students are divided into groups and given the task of building a working water filter; the ease of this task will depend on the country that the group is assigned and the access that they have to knowledge and monetary resources. The countries that students represent are from around the world and vary in their level of wealth and therefore access to resources. In order to build the water filter students must plan, purchase materials, and build a water filter using the materials they have bought and the instructions they are provided with. A comparison is drawn between a young person in a developing country and the students' own experiences with water. This further demonstrates the difference in quality of life as a result of the availability of a clean water supply. These comparisons are based on real case studies and show case work of aid agencies. The session concludes with discussion on what students can do both locally and globally to address water supply and conservation issues.

The WftW programme is divided into three age-specific modules, ensuring it hits appropriate levels of technical understanding and learning style. Well designed facilitator packs include all the information needed to run WftW in UK classrooms. This document contains the instructions and presentation required to run the Water for the World "Water Supply and the Developing World" session

Curriculum subjects suited to:

A-Level or equivalent curriculum Subjects: Geography, Science, Citizenship, Functional Skills, General Studies

Suited Age Group:

Age 14 to 16 years old. Curriculum years 10 – 11.

Session Time:

90 minutes (including 45 minutes for the workshop)

SESSION SUMMARY & REQUIREMENTS

Number of Students:

The session is designed for 20 students. However if you want to engage a larger class, arrangements need to be made for workshop materials and relevant printouts. For the workshop the students should be divided into groups of up to 4 students.

Activity Breakdown:

- Introduction.
- Class questionnaire and presentation to provide an understanding of water consumption on a local and global scale
- Introduce the components and layout of water mains infrastructure.
- Introduction to what Developing country means. Look at how water is linked to development and the correlation between water usage and how affluent a country is.
- Presentation and discussion on decontamination and health risks.
- Presentation on alternative water sources and treatment technologies.
- Practical Workshop to design, build and test a water filter using 'credit' system – poor and rich countries.
- Summary and tidy up.

Materials required

A comprehensive material list for the workshop, and suggested quantities, are detailed in the table below.

2L Plastic Bottle (1 per group)	Cotton Wool (1 bag)
1L Plastic Bottle (1 per group)	Jar of mud - to mix with approximately 2 litres of water (1 bucket)
Washing up bowl of dirty water, made from mixing tap water with mud (250ml per group)	Gravel - Coarse (2 cups per group)
250ml Beakers/cup (2 per group)	Gravel - Fine (2 cups per group)
Rubber Band (10)	Sand - Coarse (2 cups per group)
Activated Charcoal (1/4 cup per group)	Sand - Fine (2 cups per group)
Sellotape (1 roll)	Iron filings (1 cup)
Latex Gloves (1 box)	Sugar (1 beaker)
Sodium chloride (1 bottle)	Sawdust (Quarter bucket - approx 2 litres)
Cheesecloth (2 x 10cm square per group)	Scrap A3 paper (12 sheets)
Toilet paper (2 rolls)	Plastic drinking cups (40)

Equipment Required:

The following equipment would be required to run the session: **Laptop connected to projector, clamp to hold bottle, whiteboard markers and access to sink and tap or bucket of water.**

Preparation

General Guidance

The aim is to let the pupils figure things out by themselves. Focus on critical thinking making the session as interactive as possible. Prepare resources needed for the session such as Pens, Quiz sheet, Paper for answers...

1. Ensure that materials and equipment are brought to the class prior to the session
2. The school technicians should be contacted in advance to confirm the materials are available.
3. Prepare the materials and presentation and test-run the main session before the presentation day.

The Quiz

1. You need four pieces of paper with a letter **A,B,C,D** on each. Put up in different areas of the classroom beforehand.
2. It would be good to have a bucket from the school, to visually display 10-14 litres of water (depending on size of bucket)

Water Filter Workshop

1. Collect equipment and materials required for workshop including PowerPoint presentation on CD or USB stick.
2. Print activity sheets (Design Brief, Bill of Quantities).
3. Explain the steps in the activity and explain how the token system works – poor countries have less, rich have more and rich can donate to poor. Need to emphasize 'charity' is not an ideal solution (give a man a fish etc) but reflects real world.
4. Prepare 2 bottles/beakers (1 with muddy water, 1 with clear water). Use labels showing the different water qualities.
5. Organise 4 sets of materials for water filter activity.
6. Organisers need to keep track of how much each group has spent – groups can each have their own pot in the 'bank'/'shop' children can put spent tokens in to avoid confusion/cheating!
7. May need to hint that the bottle can be used upside-down.
8. They need 30mins to make the filter.
9. Just before the end ask them to run clean water through the filter to get it working.
10. Clearing up time is necessary.

Feedback

Try to get as much feedback from students and include their comments in a feedback form.

Instructions for the Presentation

The instructions below follow the PowerPoint presentation. The instructions are divided in sections.

Introduction (1mins)

Slide 1

Introductions

Give the name of the presentation (WftW – Water Supply and the Developing World) and the name of the company/organisation that has put this together (Arup/EWB)

Why the Water Issue (8 mins)

Quick Quiz

Slide 2

Put up papers with **A,B,C,D** in different areas of the classroom beforehand
Ask the students to stand up and once a question has been read out, to stand by the letter which they think is the correct answer. After each question give a bit of background.

Slide 3,4

1. About 3/4 of earth's surface is covered by water. What percentage of the world's water can we drink?

   a) 30% b) 19% c) 6% d) **0.8%**

   (Use pie chart along with images provided to display the answer)

   Source: *http://www.waterencyclopedia.com/Da-En/Drinking-Water-and-Society.html*

Slide 5, 6

2. How many people in the world are without access to drinking water?

   a) 1.1 million b) 6.7 billion c) **1.1 billion** d) 2.6 billion

   (Use column chart graphical representation to display the answer)

   Source: *http://www.worldwatercouncil.org/index.php?id=25*

Slide 7, 8, 9

3. On average how many litres of water do we use a day?

   a) 200 b) **150** c) 100 d) 50

   (Provide example comparing the daily per person water consumption in the UK - Mozambique - USA)

   Source: *http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/the_facts/water_in_the_uk.html*

Slide 10, 11

4. How many litres could be lost through leaks in this country per day?

   a) 2 million b) 50 million c) 500 million d) **900 million**

   (Using the example provided you it can be demonstrated that 900 million litres account for 20% of total volume of water that is treated. It can be explained that this is a great loss not only of water but also of money due to the fact that every single drop of water lost through leaks it has been treated first through complex physico-chemical processes that cost a lot of money. Research is in progress on finding new ways to reduce the amount of water lost through leaks)

   Source: *http://www.thameswater.co.uk/cps/rde/xchq/corp/hs.xsl/5163.htm*

Slide 12, 13

5. What percentage of domestic water is used for flushing toilets in the UK?

   a) 10% b) 20% c) 25% d) **30%**

   (Water usage in a household can be demonstrated using the pie chart provided in the presentation)

   Source: *http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/toilet_flushing.html*

Extra Questions if time allows

6. What percentage of preventable diseases is caused by unsafe drinking water, poor sanitation and hygiene?

   a) 33% b) 44% c) 66% d) **88%**

   Source: *http://www.cdc.gov/healthywater/global/wash_statistics.html*

7. How much do you think it costs to fill a bath in the UK?

   a) 2p b) **15p** c) 20p d) 25p

   Source: *http://www.uswitch.com/water/how-much-water-use/*

Slide 14

Personal Water Usage

How much water do we use? Ask class the questions below. Discuss the facts and what their perception of them was.

- How long can we live without food? 4 - 8 Weeks

  Source: *http://www.professorshouse.com/food-beverage/food/how-long-can-a-person-survive-without-food.aspx*

- How long can we live without water? 3 - 5 Day

  Source: *http://www.professorshouse.com/food-beverage/food/how-long-can-a-person-survive-without-food.aspx*

- Really?! How much do we need per day? 30 – 50 Litres
- Okay… How much do we use? 140 – 160 Litres

  Source: *http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/the_facts/water_in_the_uk.html*

Slide 15

Where does it all go?

Ask class the questions below. Discuss the facts and what their perception of them was.

- Brushing teeth : 0.01 - 1 L
- Drinking: 1 - 2 L
- Cooking: 1 - 5 L
- Washing hands and face : 1 - 3 L
- Flushing the toilet : 5 - 10 L
- Having a power shower/bath : 50 - 150 L
- Having a shower: 1 - 40 L
- Washing machine: 30-100 L
- Dish washer: 30 - 100 L
- Cleaning car: 5 - 200 L
- Watering garden 1 -17 litres per m2
- Total on average per person: 150 - 160 L

The Global Picture (7 mins)

Statistical maps: Explain statistical maps. Be aware of not confusing the pupils with percentages. Use colours to aid their intuition. ***Water Scarcity***, is the most important map, it can be seen as an overlap of the ***Consumption*** and ***Availability of Water*** maps.

Slide 16

Global Water Consumption / Water Footprint

A country's internal water footprint is the volume of water used from domestic water resources. Water is then used in agriculture, industry and domestic uses. Therefore this map actually illustrates the per capita water consumption from domestic water resources around the world *(Comments can be made regarding the very low water consumption in African Countries, India and China in comparison with the high water consumption in the USA).*

Read more on:

http://www.unesco.org/water/wwap/wwdr/wwdr3/pdf/WWDR3_Water_in_a_Changing_World.pdf

http://www.waterfootprint.org/?page=files/Publications (Hoekstra and Chapagain 2008)

Slide 17

Availability of Water

On our blue planet 97.5% of the water is saltwater, unfit for human consumption. The majority of freshwater is beyond our reach, locked into polar snow and ice. Less than 1% of freshwater is usable, amounting to only 0.01% of the Earth's total water. Even this would be enough to support the world's population three times over, if used with care. However, water like population isn't distributed evenly. Asia has the greatest annual availability of fresh-water and Australia the lowest. But when population is taken into account the picture looks very different. (Point out in the map that though Asia has the greatest annual availability of fresh-water as a region, the availability of water per capita is very low because it is so densely populated. Moreover, though Australia has the lowest annual availability of fresh-water as a region, the availability of water per capita is high because of its low population.

Source: http://www.newint.org/issue354/facts.htm

Source: http://highered.mcgraw-hill.com/sites/007248179x/student_view0/chapter14/web_map_4.html

Slide 18

Water Scarcity

Explain what Physical and Economic water scarcity is.

Physical water scarcity: Areas where people have to physically cover long distances (up to several hours) to reach a water source and then carry water back to the household.

Economic water scarcity: Clean treated water is available but it has become too expensive to afford. People that can not afford it travel to closest water source from where they get untreated water but free of charge.

Point out on the map the difference between USA, Europe and Africa, Middle East and India.

Source: http://www.cspo.org/gck/picweek.htm

Mention that lack or fresh water consequently means no irrigation and thus food shortage. The food price is going up, causing more misery for the world's poor. The geopolitical shockwaves have spread round the world, with food riots in Haiti, strikes over rice shortages in Bangladesh, tortilla wars in Mexico, and protests over bread prices in Egypt.

Source: http://www.iwmi.cgiar.org/news_room/pdf/Water_Scarcity_%20he_Real_Food_Crisis.pdf

Infrastructure (4 mins)

Slide 19, 20, 21

Introduction

How do we get clean water?

- Your water company is obliged to provide you with potable water How do they do this?
- comes to your house in a blue pipe
- Before that it is piped along the streets in bigger blue pipes!
- Water Treatment Process (Explain the process. Water abstraction from the source (e.g. river) >> Add Chemicals (Coagulation tank: Destabilization of suspended particles using chemicals) >> Stirring (Flocculation tank: Low speed stirring so that destabilized particles can create flocs that settle easier) >> Settlement (Sedimentation tank: Flocs are allowed to settle) >> Filtration unit (Removal of persistent suspended solids using filters) >> Disinfection (Using chlorine to biologically clean water from bacteria, viruses, protozoa etc. >> Storage >> Distribution Network >> Households

Slide 22, 23, 24, 25, 26

Alternative Water Sources

When people do not have access to a mains supply such as we have, they have to firstly find some water

- Ground (Wells)

  (Water that falls to the earth can seep into the ground where it moves in a downward direction due to gravity until it reaches a soil depth where the ground is already filled with water. The top of this saturated with water zone is called the water table and that can be very close to the ground surface or even up to 600 feet deep. People can access ground water through a ground well which is basically a hole in the ground that allows access to the water table below ground level)

- Springs

  ("A spring is a natural occurrence where water flows on to the surface of the earth from below the surface". Groundwater travels through various cracks, fissures and openings inside the earth. When the water finally emerges from below the surface, it forms a spring. In succession the spring may result in the creation of a stream or a lagoon close to the exit point.)

- Lakes and Rivers

  (River is a natural watercourse flowing toward an ocean, lake or sea. A lake is a body of water of considerable size that is surrounded by land. Both rivers and lakes are used as water sources but in most cases their water is polluted and therefore non potable)

- Sea

  (Sea water can also be used after excess salt and minerals have been removed. This process is called desalination and can lead to potable water quality.)

- Roofs! (Rainwater Harvesting)

  (Rainwater harvesting is the gathering or rainwater that can be used as drinking water, water for livestock and for irrigation.)

  Source: http://www.wikipedia.org/

Slide 27, 28

Developing Countries (10 mins)

Explain to the class what a Developing Country is:

- Low standards of democratic governments

(Usually a small group of people has the power rule over others \ Many African countries were subject to military takeover - others maintained as democracies only in name \ Absence or faulty functioning of a constitution that protects and promises certain legitimized freedoms and liberties.)

- Weak Economy

An example could easily make a good point here. Example: The average annual salary in the UK is around £27k. The annual average salary in Nigeria is around $330

Source: http://www.payscale.com/research/UK/Country=United_Kingdom/Salary

Source: http://blogs.cgdev.org/globaldevelopment/2005/04/a-buyback-to-resolve-nigerias-debt-problem.php

- Low standards of industry
- Low standards of social welfare and social programs

(Low standards of educational rights, low standards of food, work, clothing, housing and medical care.)

- Low standard of human rights

(Low standards of equality of opportunity for youth and for others, no jobs, no security for those who need it, special privileges for the few, poor preservation of civil liberties, no scientific progress, no political rights)

Slide 29

World Development Map

World Development Map illustrates advanced economies (with a high level of development - industry), emerging economies (in the process of rapid growth and industrialization) and developing economies (with a low level of material well being).

(Draw students' attention to the high percentage of developing economies in Africa)

(At this point you can ask the students how much they know about the poorest countries in the world and provide some facts and stats about these countries like:

- *Around 27-28 percent of all children in developing countries are estimated to be underweight or stunted. The two regions that account for the bulk of the deficit are **South Asia and sub-Saharan Africa**.*
- *Based on enrolment data, about 72 million children of primary school age in the developing world were not in school in 2005; 57 per cent of them were girls. And these are regarded as optimistic numbers.*
- *Less than one per cent of what the world spent every year on weapons was needed to put every child into school by the year 2000 and yet it didn't happen.*
- *Infectious diseases continue to blight the lives of the poor across the world. An estimated 40 million people are living with HIV/AIDS, with 3 million deaths in 2004. Every year there are 350–500 million cases of malaria, with 1 million fatalities: Africa accounts for 90 percent of malarial deaths and African children account for over 80 percent of malaria victims worldwide.*
- *Some 1.8 million child deaths each year as a result of diarrhoea*
- *Number of children in the world: 2.2 billion; Number in poverty 1 billion (every second child); Children out of education worldwide: 121 million)*

Read more on: http://www.globalissues.org/article/26/poverty-facts-and-stats

Water infrastructure in Developing Countries (10 mins)

Slide 30

Explain that people in Developing Countries lack the privilege of a water supply network. They don't have running water in their households.

Best case scenario, water is delivered by ***water-tank cars.***

Slide 31

People are pumping groundwater through ***pumping wells***. (In many cases there is only one well per village or one well serving more than one villages)

Read more: http://www.waterencyclopedia.com/

Slide 32

Other Sources

People usually obtain water from rivers or lakes (surface water) the time spent hauling water can be significant in areas where sources of domestic water supply are limited.

Read more: http://www.waterencyclopedia.com/Da-En/Developing-Countries-Issues-in.html#ixzz0XDmewvUK

Slide 33, 34, 35, 36

Contamination

When people find water it is rarely of drinkable quality. Water in most cases is both chemically and biologically unsuitable for consumption.

Biological Contamination (Microorganisms): Bacteria, Viruses, Protozoa, Metazoa (Helminths ect.)

Chemical Contamination: Dissolved Chemicals

Turbidity: Particulates, Suspended Solids

Waterborne diseases like Cholera, Typhoid fever, Salmonella thrive due to low standards of water treatment, disinfection and sanitation.

Slide 37

Treatment - Simple Technology

- Slow sand filtration - Biosand Filters: Slow sand filters are typically rectangular or cylindrical and 1 to 2 meters deep (Length and Width determined by the water flow rate). Slow sand filters use biological processes to clean the water. A gelatinous layer called hypogeal (or Schmutzdecke) is formed on the top few millilitres of the fine sand layer. This layer consists of bacteria, fungi, protozoa, metazoa, snails and worms and is the one responsible for the effective purification of the water. As water passes through the Schmutzdecke, particles of foreign matter are trapped in the mucilaginous matrix and dissolved organic material is adsorbed and metabolised by the bacteria, fungi and protozoa. The water produced from a well-managed slow sand filter can be of exceptionally good quality with 90-99% bacterial reduction.

Source: http://en.wikipedia.org/wiki/Slow_sand_filter

- Ceramic Water Filters (CWF) : CWF systems consist of a porous ceramic filter that sits on top of a plastic or ceramic receptacle. Contaminated water is poured in the filter and passes through the filter into the receptacle below. Only water and smaller contaminants will pass through to the other "clean" side of the filter, contaminants which are larger than the minute holes of the ceramic structure will remain in the top half of the unit, which can be cleaned by brushing the inside of the top section with a soft brush and rinsing it out.

Source: http://en.wikipedia.org/wiki/Ceramic_water_filters

(Explain the process using the illustrations provided in the presentation)

Slide 38, 39, 40, 41

Water filter Workshop (45mins)

General Instructions

- In groups, make a ***workable*** water filter
- Each group is a country
- Print Country Sheets and Bill of Quantities for student use.
- Follow the instruction sheet (Country Sheet eg. UK, Zambia etc.)
- Buy supplies and keep a note of everything in the 'Bill of Quantities'
- Demonstrate filter at end.

Rules

- Only one Person buys at a time.
- You can only buy in the first 20 min
- You can talk and deal with other groups

Discussion

- Get the students to think about what they can do to reduce their personal water consumption
- Get the students to think about how they can support work of NGOs overseas/reduce water consumption in UK e.g. fundraising and awareness campaigns

Slide 42

Call to Action (5mins)

What can you do now? You are being given a handout one of them provides a calculation for working out your daily water consumption. You can compare this to the UK average. One of the benchmarks for domestic design, recognized for its reduction in energy and water consumption demands a water consumption of 80 litres per person. Think about how you would achieve this and consider the water hierarchy of reducing demand, alternative water sources such as rainwater, and water recycling. Usually engineering calculations involve breaking down the problem into simpler steps. You should be able to think of the method of calculation yourself and just use the methods provided to check against the method you followed. There are different ways of finding a given solution, which may also vary depending on the method and assumptions used. Have you heard of the concept of the carbon footprint? How would you work out your water footprint? Similarly you can find a method for calculating the annual water consumption per person at your school. The UK benchmark is 11m3 per pupil per year. There are guidelines for this calculation on the Thames Water website.

Water and sanitation provision are key to development and are in one way or another related to all of the United Nation's Millennium Development Goals. This year, WaterAid is running a campaign to urge leaders at the G8 to put resources towards this. You could contact WaterAid and find out how to run a campaign at your school and they can provide you with resources such as postcards, badges campaign packs. Similarly you can raise awareness to other students at your school about the issues presented today and measures they can take to reduce water consumption.

You can also find out more about a career or voluntary work in water engineering or development. There are different aspects of water engineering. Water Engineers usually work on flood risk analysis, design of water treatment plants, reservoirs, and infrastructure. Water services in buildings are designed by public health or environmental services engineers. As climate change has more severe and visible effects on water supply and drainage there are new challenges for engineers and we need to look for innovative and holistic solutions, and not take a business as usual approach. Look for water related modules or modules about appropriate or intermediate technology in the courses you are planning to study.

Useful sites for background knowledge to explain the maps shown on the slides

http://www.waterfootprint.org/?page=files/home

http://www.iwmi.cgiar.org/

http://www.wateryear2003.org/en/ev.php-URL_ID=5878&URL_DO=DO_TOPIC&URL_SECTION=201.html

Information for the Teachers

Background information

This workshop forms the practical part of the Water for the World "Water Supply and the Developing World" Module.

The aim of the activity is for the students to build a working water filter however, the ease of this task will depend on the country that the group is assigned to and the access that they have to knowledge and monetary resources. The countries that students represent are from around the world and vary in their level of wealth, literacy, technical knowledge and access to resources. The varied instructions, their clarity and amount of available funds to each group, represent the disparity between the countries. Following the workshop each group should present to the rest of the class (with the teacher's help) the process they went through and the challenges they had. After each group presents, the facilitator should lead a discussion on the differences of experience and explain how these challenges are also met by people in developing countries, where lack of funds and knowledge prevents them from accessing basic services such as drinking water and adequate sanitation.

In order to build the water filter students must plan, purchase materials, and build a water filter using the materials they buy and the instructions they are provided with. Each group will carry out these tasks following the instructions provided in the respective "Country Sheets". The groups have different amounts of money and information available to them. The teachers/facilitators should familiarize themselves with the different requirements of the groups in order to distribute the monopoly money and answer any questions. The teacher/facilitator will manage the distribution of the material and set up a "shop front". It is important to establish a Rota of queuing for the children to by materials at the "shop front".

The workshop is intended to take 45 minutes (including set-up and clear-up). Follow up discussions can be tailored to time constraints.

This document includes:

- The task and suggested timings
- Preparation for the task
- Discussion topics

Workshop Execution

1. **Split the class into groups of 4 and assign each group a country**
2. **Supply students with Workshop Sheets (Print and distribute Country Sheets and Bill of Quantities to students)**
3. **Allow them time to read through (no longer than 5 minutes)**
4. **Clarify any queries**
5. **Groups cannot buy supplies all at once, allocate an order to the groups, groups must nominate only one person who can buy materials.**
6. **Once all have materials allow them time to build and run water through their filter (no longer than 20 minutes)**
7. **Have muddy water pre mixed, then get each group to come and test filter.**
8. **Students will present the process and the challenges they had. (no longer than 10 minutes)**
9. **Explain the relevance of these challenges to the real world**
10. **Discuss.**

Further Discussion

Money/Disadvantage

After the filters have been tested tell the groups (though they should have realized) that they were all given different amounts of money and information depending on what country they represented. This is to:

- Highlight the fact that poorer countries may struggle to provide the money and materials to provide clean water to the population
- With a lower literacy rate it is harder to transmit the information to the populace

Discuss how they felt

- Whether the rich countries feel superior / sorry for the less fortunate / ignorant?
- The less advantaged countries felt unfairly treated/pride in their achievement/jealous of other groups?

How Filter Works

Ask students how filter works:

- Sand + gravel filters keep out solid material, like a number of sieves
- Activated Charcoal acts as a filter, highly porous, and also removes chemicals such as chlorines, dyes and pesticides by adsorbing them to surface. (highly porous therefore large surface area)

What does the filter not remove, and why? How could this be tackled?

- Very small objects e.g. virus and bacteria
- Other forms of filters available that could be used involving ceramics made from clay and local materials such as rice husks or bran, which when fired decompose producing CO2 ¬creating tiny porous that traps most things. Adding biocides such as silver improves them
- Boiling water kills most pathogens.

What needs to happen to the materials before being used in a filter?

- Materials themselves would need to be clean

Materials and Equipment

Materials

A comprehensive materials list for the workshop, and suggested quantities, are detailed in the table below. The quantities have been assumed for a class of 20 students (5 groups). For larger numbers of students and groups the materials should be scaled appropriately.

Description	Quantity	Available?
2 litre bottle	5	
1 litre bottle	5	
Jar of mud (to mix with approximately 2 litres of water)	1	
250ml beaker/cup	10	
Rubber band	10	
Sellotape	1 roll	
Iron filings	1 cup	
Activated charcoal (granules) - not essential	2 x 250ml beaker full	
Cheesecloth or equivalent	5 x 10cm squares	
Sugar	1 small bag/beaker full	
Cotton wool	1 bag	
Latex gloves	1 box	
Gravel - coarse	Quarter bucket (approx 2 litres)	
Gravel - fine	Quarter bucket (approx 2 litres)	
Sand- coarse	Quarter bucket (approx 2 litres)	
Sand - fine	Quarter bucket (approx 2 litres)	
Sodium chloride	1 bottle	
Sawdust	Quarter bucket (approx 2 litres)	
Toilet paper	2 rolls	
A3 paper	12 sheets	
Plastic drinking cups	40	

Equipment

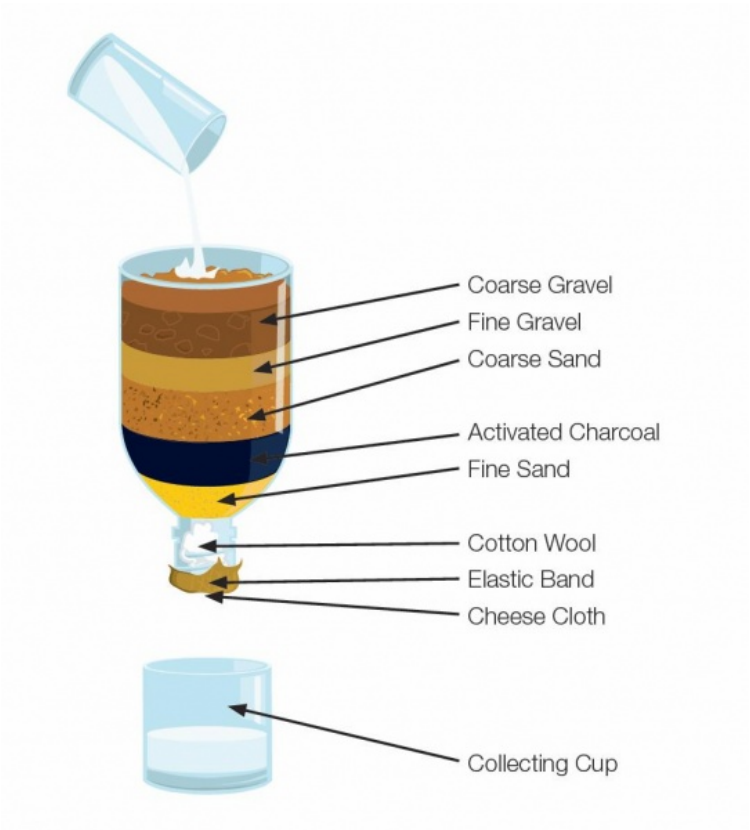
The following equipment would be required to run the session:

Description	Quantity
Clamp	5
White board markers	10
Prit Stick	-
Scissors	-
Access to sink and tap or bucket of water	-
10-14 litre bucket (if possible)	1

NB: Students are not required to use all the materials – some offer no advantage for filtering. Iron filing, sodium chloride, sawdust are not actually required to make the filter but should be provided so that the students have to make a choice of suitable materials. It is advisable to take surplus materials if available. The teams should use the bill of quantities provided to order their materials. Only one representative from each group may come to purchase materials, one group at a time.

Filter diagram (for teachers only)

The filter diagram below includes all the information regarding the filter composition. **Do not make this image available to the groups**. Some of the groups like the USA and UK will have a version of this in their instructions.



The following sheets should be printed out separately and handed out to each group.

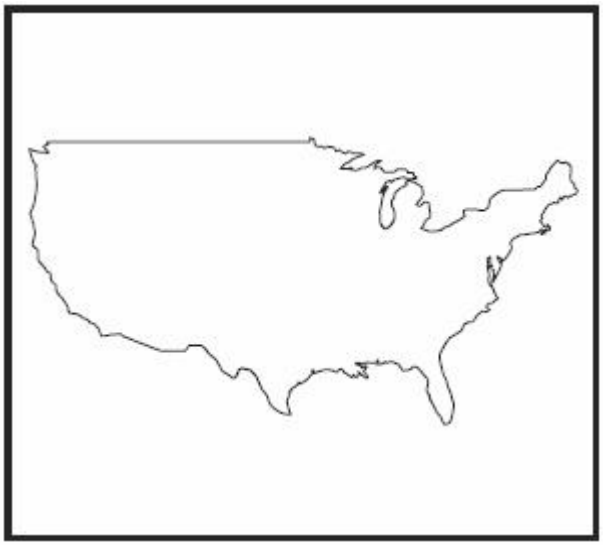
Bill of Quantities (this sheet is meant to be printed for student use)

Team: _____

Total Budget = _____ credits

Material	Unit Cost	Quantity Required	Total Cost
2 litre bottle	10 credits		
1 litre bottle	5 credits		
Capture Cup	2 credits		
Rubber Band	2 credits each		
Sellotape	2 credits/10cm		
Iron filings	15 credits/teaspoon		
Activated charcoal	30 credits per 1/4 cup		
Cheesecloth	4 credits/square		
Sugar	5 credits/cup		
Cotton wool	2 credits/ball		
Latex gloves	10 credits		
Gravel - coarse	5 credits/cup		
Gravel - fine	5 credits/cup		
Sand- coarse	10 credits/cup		
Sand - fine	15 credits/cup		
Sodium chloride	10 credits/cup		
Sawdust	5 credits/cup		
Toilet paper	2 credits/sheet		
A3 paper	2 credits/sheet		
		Grand Total	=

USA Country Sheet **(this sheet is meant to be printed for student use)**



USA Quick Facts

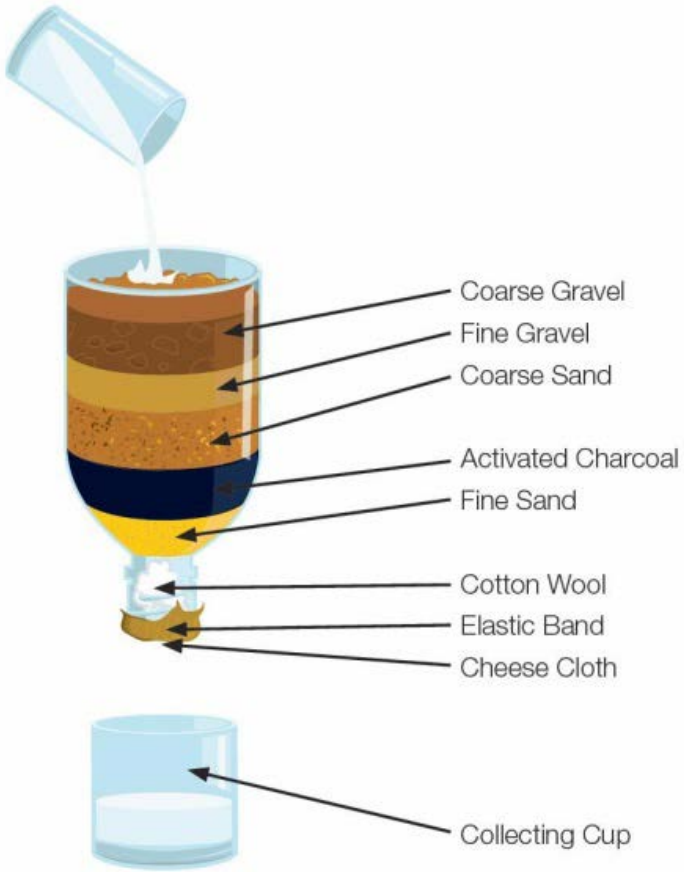
- The USA is one of the wealthiest and most prosperous countries in the world with a GDP (Gross Domestic Product) of $14 trillion.
- Population: 314,659,000
- Literacy: 99% of the population have completed 5 or more years of schooling,
- Rainfall: The characteristics of United States rainfall climatology differ significantly across the United States.

Sources:

International Monetary Fund (2009)
http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/weorept.aspx?sy=2009&ey=2009&scsm=1&ssd=1&sort=country&ds=.&br=1&c=453%2C732%2C112%2C111%2C754&s=NGDPD&grp=0&a=&pr1.x=84&pr1.y=11

Department of Economic and Social Affairs Population Division (2009)
http://www.un.org/esa/population/publications/wpp2008/wpp2008_text_tables.pdf
Central Intelligence Agency Library (Latest Information) https://www.cia.gov/library/publications/the-world-factbook/fields/2103.html
The wetter portions of the nation exceed 760 mm per year (World Average 962.7mm)
http://en.wikipedia.org/wiki/United_States_rainfall_climatology

USA Project Brief Sheet (this sheet is meant to be printed for student use)



Instructions

You need to build a filter, to clean your water supply. Use the instructions below:

1. Loosely plug neck with cotton wool
2. Secure cheesecloth around neck of bottle, using an elastic band
3. Pour a 1 cm layer of fine sand into the bottle (as illustrated)
4. Add a layer of activated charcoal
5. On top of this, insert coarse sand
6. The next layer should be made up of fine gravel
7. The upper-most layer should be 1 cm deep with coarse gravel.
8. Remember to pour clean water through your filter to get it working.

You have **400 credits** to build your filter from the resources supplied.

The cost of materials is listed below:

Material	Description	Cost
Cheesecloth	Fine non-water resistant cloth	4 credits/square
Cotton wool	Fine wadding	2 credits/ball
Activated Charcoal	Highly porous carbon with large surface area. Carbon based compounds and chlorine adsorbed to the surface.	30 credits per 1/4 cup
Gravel - Coarse	Act as a sieve, allowing different particle sizes past	5 credits/cup
Gravel - Fine	"	5 credits/cup
Sand - Coarse	"	10 credits/cup
Sand - Fine	"	15 credits/cup
Rubber band	-	2 credits each
Plastic Bottle	-	10 credits
Capture Cup	Collects water	2 credits

UK Country Sheet **(this sheet is meant to be printed for student use)**

UK Quick Facts

The United Kingdom is a leading trading power and financial centre

- **Population:** 61,565,000
- **GDP:** $2.198 trillion.
- **Literacy:** 99% of the population have completed 5 or more years of schooling,
- **Natural Hazards:** Winter windstorms and floods
- **Annual Rainfall:** 737mm (World Average 962.7mm)

Sources:

Department of Economic and Social Affairs Population Division (2009)
http://www.un.org/esa/population/publications/wpp2008/wpp2008_text_tables.pdf

International Monetary Fund (2009)
http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/weorept.aspx?sy=2009&ey=2009&scsm=1&ssd=1&sort=country&ds=.&br=1&c=453%2C732%2C112%2C111%2C754&s=NGDPD&grp=0&a=&pr1.x=84&pr1.y=11

Central Intelligence Agency Library (Latest Information) https://www.cia.gov/library/publications/the-world-factbook/fields/2103.html

http://www.skyscrapercity.com/showthread.php?t=349393

CIA World Fact book

UK Project Brief Sheet (this sheet is meant to be printed for student use)

Instructions

You need to build a filter, to clean your water supply. Use the instructions below:

1. Loosely plug neck with cotton wool
2. Secure cheesecloth around neck of bottle, using an elastic band
3. Pour a 1 cm layer of fine sand into the bottle (as illustrated)
4. Add a layer of activated charcoal
5. On top of this, insert coarse sand
6. The next layer should be made up of fine gravel
7. The upper-most layer should be 1 cm deep with coarse gravel.
8. Remember to pour clean water through your filter to get it working.

You have **150 credits** to build your filter from the resources supplied. The cost of materials is listed below

The cost of materials is listed below:

Material	Description	Cost
Cheesecloth	Fine non-water resistant cloth	4 credits/square
Cotton wool	Fine wadding	2 credits/ball
Activated Charcoal	Highly porous carbon with large surface area. Carbon based compounds and chlorine adsorbed to the surface.	30 credits per 1/4 cup
Gravel - Coarse	Act as a sieve, allowing different particle sizes past	5 credits/cup
Gravel - Fine	"	5 credits/cup
Sand - Coarse	"	10 credits/cup
Sand - Fine	"	15 credits/cup
Rubber band	-	2 credits each
Plastic Bottle	-	10 credits
Capture Cup	Collects water	2 credits

Qatar Country Sheet **(this sheet is meant to be printed for student use)**

Qatar Quick Facts

Qatar is one of the driest countries in the world – it receives only 81mm of water each year. As a result, they have built large numbers of water treatment plants to turn salty sea water into fresh drinkable water.

- **Population:** 1,409,000
- **GDP:** $92.541billion.
- **Literacy:** 89% of over 15-year olds can read and write,
- **Rainfall:** 81mm (World Average 962.7mm)

Sources:

Department of Economic and Social Affairs Population Division (2009)
http://www.un.org/esa/population/publications/wpp2008/wpp2008_text_tables.pdf

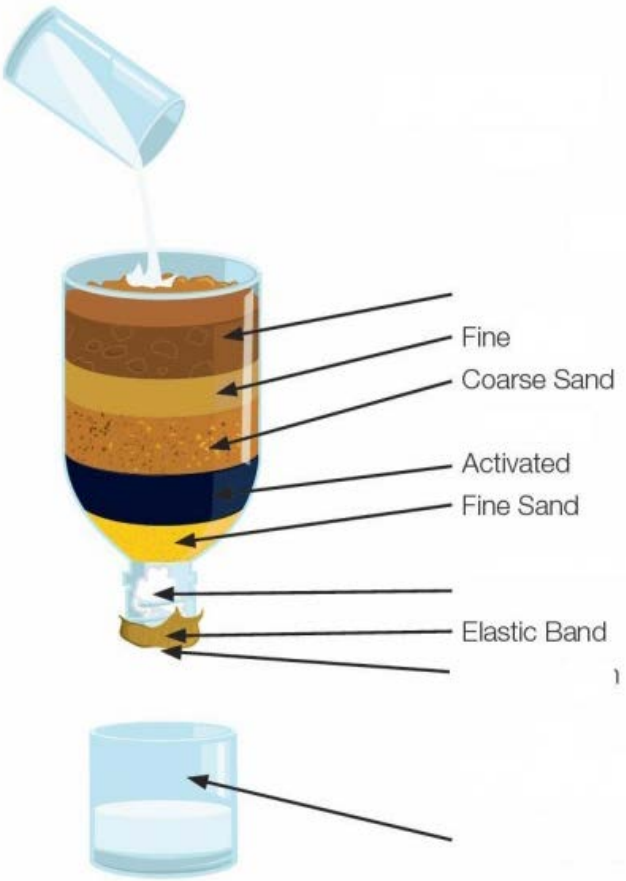
International Monetary Fund (2009)
http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/weorept.aspx?sy=2009&ey=2009&scsm=1&ssd=1&sort=country&ds=.&br=1&c=453%2C732%2C112%2C111%2C754&s=NGDPD&grp=0&a=&pr1.x=84&pr1.y=11

Central Intelligence Agency Library (Latest Information) https://www.cia.gov/library/publications/the-world-factbook/fields/2103.html

http://www.qatarembassy.net/environment.asp

CIA World Fact book

Qatar Project Brief Sheet (this sheet is meant to be printed for student use)



Instructions

You need to build a filter, to clean your water supply. Use the instructions below:

1. Loosely plug neck with cotton wool
2. Secure cheesecloth around neck of bottle, using an elastic band
3. Pour 1 cm layer of fine sand into the bottle (as illustrated)
4. Add a layer of a(KAS charcoal
5. Add further layers of $a&d and %ra^el
6. Remember to pour clean water through your filter to get it working.

You have **100 credits** to build your filter from the resources supplied.
The cost of materials is listed below

The cost of materials is listed below:

Material	Description	Cost
Cheesecloth	Fine non-water resistant cloth	4 credits/square
Cotton wool	Fine wadding	2 credits/ball
Activated Charcoal	Highly porous carbon with large surface area. Carbon based compounds and chlorine adsorbed to the surface.	30 credits per 1/4 cup
Gravel - Coarse	Act as a sieve, allowing different particle sizes past	5 credits/cup
Gravel - Fine	"	5 credits/cup
Sand - Coarse	"	10 credits/cup
Sand - Fine	"	15 credits/cup
Rubber band	-	2 credits each
Plastic Bottle	-	10 credits
Capture Cup	Collects water	2 credits

Sudan Country Sheet (this sheet is meant to be printed for student use)

Sudan Quick Facts

Sudan is a third world country. It has major problems related to inadequate supplies of potable water; wildlife populations threatened by excessive hunting; soil erosion; desertification; periodic drought.

- **Population:** 42,272,000,
- **GDP:** $54.294 billion.
- **Literacy:** 61% of over 15-year olds can read and write,
- **Rainfall:** 164 mm (World Average 962.7mm)

Sources:

CIA World Fact book

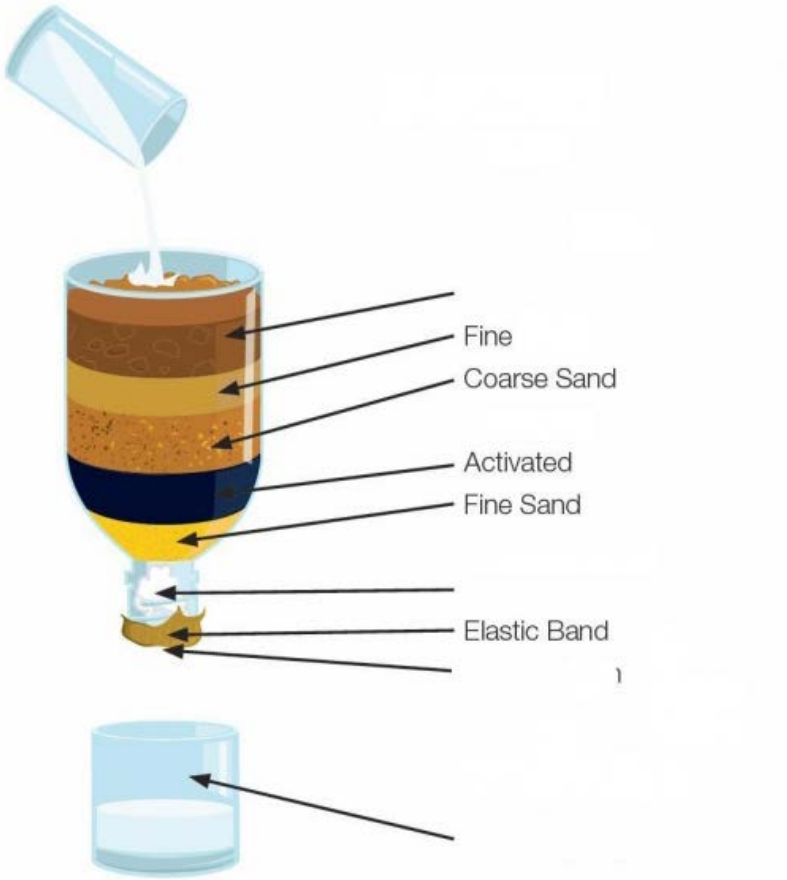
Department of Economic and Social Affairs Population Division (2009)
http://www.un.org/esa/population/publications/wpp2008/wpp2008_text_tables.pdf

International Monetary Fund (2009)
http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/weorept.aspx?sy=2009&ey=2009&scsm=1&ssd=1&sort=country&ds=.&br=1&c=453%2C732%2C112%2C111%2C754&s=NGDPD&grp=0&a=&pr1.x=84&pr1.y=11

Central Intelligence Agency Library (Latest Information) https://www.cia.gov/library/publications/the-world-factbook/fields/2103.html

http://www.climatetemp.info/sudan/

Sudan Project Brief Sheet (this sheet is meant to be printed for student use)



Instructions

You need to build a filter, to clean your water supply. Use the instructions below:

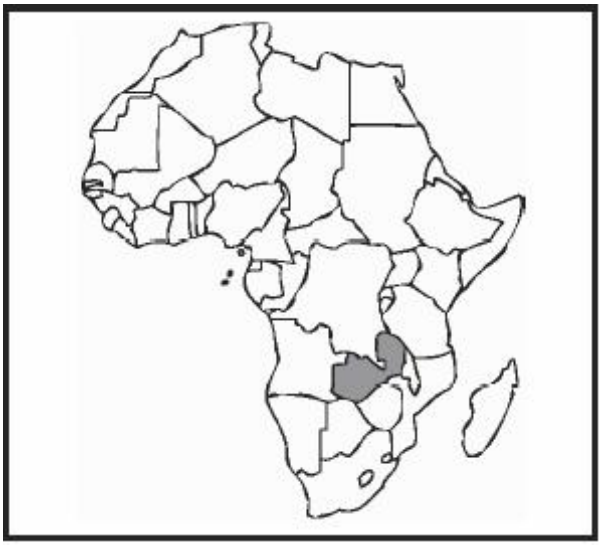
1. Loosely plug n(&&k with cotton wool
2. Secure cheesecloth around neck of bottle, using an elastic ban£
3. Pour a $%& cm layer of fine sand into the bot=le (as illustrated)
4. Add a layer of a(KAS charcoal
5. Add fur()er layers of $a&d and %ra^el
6. Remember to pour clean water through your filter to get it working.

You have **40 credits** to build your filter from the resources supplied.

The cost of materials is listed below:

Material	Description	Cost
Cheesecloth	Fine non-water resistant cloth	4 credits/square
Cotton wool	Fine wadding	2 credits/ball
Activated Charcoal	Highly porous carbon with large surface area. Carbon based compounds and chlorine adsorbed to the surface.	30 credits per 1/4 cup
Gravel - Coarse	Act as a sieve, allowing different particle sizes past	5 credits/cup
Gravel - Fine	"	5 credits/cup
Sand - Coarse	"	10 credits/cup
Sand - Fine	"	15 credits/cup
Rubber band	-	2 credits each
Plastic Bottle	-	10 credits
Capture Cup	Collects water	2 credits

Zambia Country Sheet **(this sheet is meant to be printed for student use)**



Sources:

Department of Economic and Social Affairs Population Division (2009) http://www.un.org/esa/population/publications/wpp2008/wpp2008_text_tables.pdf

International Monetary Fund (2009) http://www.imf.org/external/pubs/ft/weo/2009/02/weodata/weorept.aspx?sy=2009&ey=2009&scsm=1&ssd=1&sort=country&ds=.&br=1&c=453%2C732%2C112%2C111%

Central Intelligence Agency Library (Latest Information) https://www.cia.gov/library/publications/the-world-factbook/fields/2103.html

http://www.studentsoftheworld.info/pageinfo_pays.php3?Pays=ZAM&Opt=climate

Zambia Quick Facts

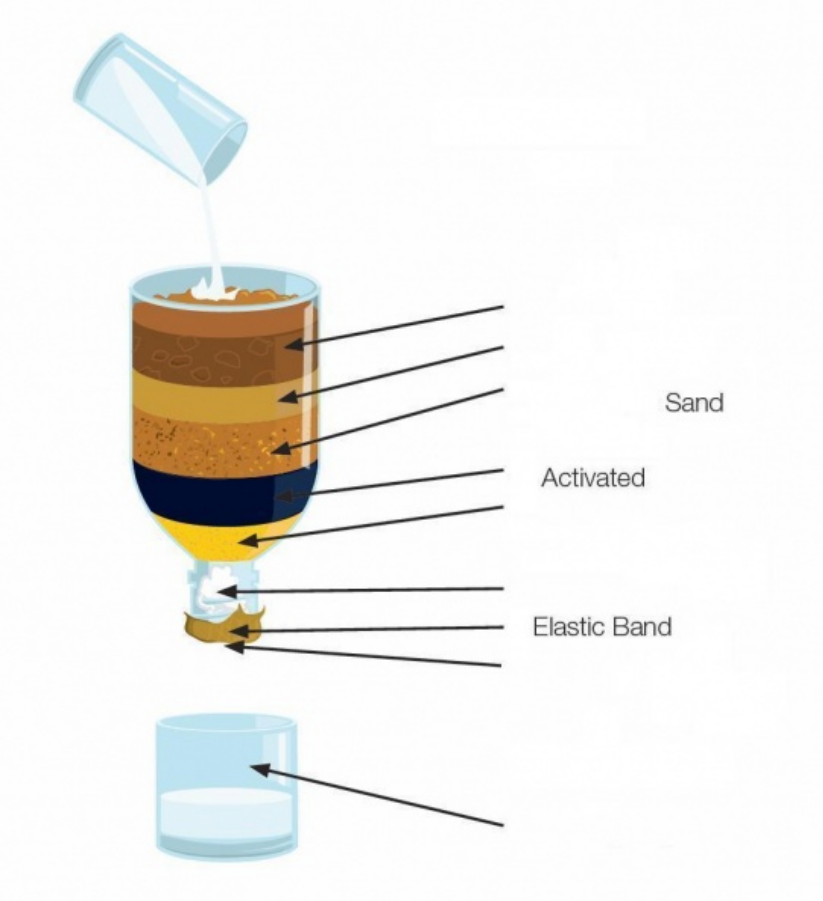
- Zambia is one of the poorest countries in the world. 86% of people live below the poverty line. This is over double the world average.
- The risks of contracting a disease are very high.

The most widespread water diseases are:

- *diarrhea (leads to dehydration, hyperactive secretion and death)*
- *schistosomiasis (coughing, fever and fatigue)*
- *typhoid fever (causes internal bleeding)*

- **Population:** 12,935,000,
- **GDP:** $12.293 billion,
- **Literacy:** 80.6% of the population over 15 can read and write,
- **Rainfall:** 178mm/month during wet season (October - April) (World Average 962.7mm)

Zambia Project Brief Sheet (this sheet is meant to be printed for student use)



Instructions

You need to build a filter, to clean your water supply. Use the instructions below:

1. Cut bottle in ak&%sua
2. Loosely plug neck with cotton wool
3. Secure cheesecloth around UASJ**"& of bottle, using an HQTY^!" band
4. *"^&"Jjskkla00 (!"("
5. Add *!"ISM activated charcoal
6. JAUUQ&&*!!__"((coarse sand
7. KKAMHHA((!**!HHASU&&*"* gravel
8. KKAI&!^"Y"HS^&^!((")SJJS 00
9. Remember to pour clean water through your filter to get it working.

You have 20 credits to build your filter from the resources supplied. The cost of materials is listed below

The cost of materials is listed below:

Material	Description	Cost
Cheesecloth	Fine non-water resistant cloth	4 credits/square
Cotton wool	Fine wadding	2 credits/ball
Activated Charcoal	Highly porous carbon with large surface area. Carbon based compounds and chlorine adsorbed to the surface.	30 credits per 1/4 cup
Gravel - Coarse	Act as a sieve, allowing different particle sizes past	5 credits/cup
Gravel - Fine	"	5 credits/cup
Sand - Coarse	"	10 credits/cup
Sand - Fine	"	15 credits/cup
Rubber band	-	2 credits each
Plastic Bottle	-	10 credits
Capture Cup	Collects water	2 credits