Research
Based
Curricula

Water Sustainability & Greywater Reuse in Agriculture

Key Stage 5 Geography

2020

University of Reading | AccessEd Research-Based Curricula

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For Students
Getting Started

RBC means Research-Based Curriculum,. Each RBC coursebook is written by a PhD student at a university about their cutting edge research.

Why complete an independent 'RBC' study pack?

RBC courses are challenge courses to sharpen your skills and resilience: finishing a RBC course is a major accomplishment to add to your academic CV. To get into the university, you must demonstrate that you are intellectually curious, and will make the most of the academic opportunities available to you. Completing a pack will allow you to gain invaluable experience to write about in your university application..

It allows you to:

- ✓ Build your subject experience to mention in your UCAS Personal Statement
- ✓ Sharpen your academic skills
- ✓ Experience what it's like to study beyond school and at university
- ✓ Better understand what you enjoy and don't
- ✓ Improve your overall subject understanding ahead of final exams

For Students
Getting Started

What's in this booklet?

Your RBC booklet is a pack of resources containing:

- ✓ More about how and why study this subject
- ✓ Six 'resources' each as a lesson with activities
- ✓ A final assignment to gauge learning
- ✓ Extra guidance throughout about the university skills you are building
- ✓ End notes on extra resources and where to find more information

Who should complete this pack?

Anyone interested in improving their academic skills or understanding what they should do at university. *This pack is especially great for anyone interested in studying* ***Geography****, and are interested in learning more about a new topic.*

Even if you are unsure of where your interest in these subjects can take you, by completing this pack you will have a clearer idea of the variety of subjects that link to one another.

If you have any questions while you are using the resources in this pack, you can contact your teacher or email us directly at schools@access-ed.ngo.

Good luck with your journey to higher education!

For Students
University Skills

To complete this resource, you will have to demonstrate impressive academic skills. When universities are looking for new students, they will want young people who can study independently and go above and beyond the curriculum. All of these skills that you will see here will demonstrate your abilities as a university student – while you're still at school!

Every time you have to look something up, or write up a reference you are showing that you can work independently.

Every time that you complete a challenging problem or write an answer to a difficult question, you might demonstrate your ability to think logically or build an argument.

Every time that you evaluate the sources or data that you are presented with, you are showing that you can "dive deep" into an unfamiliar topic and learn from it!

Skills you will build for university:

independent research	your ability to work on your own and find answers online or in other books
creativity	your ability to create something original and express your ideas
problem solving	your ability to apply what you know to new problems
building an argument	your ability to logically express yourself
providing evidence	your ability to refer to sources that back up your opinions/ ideas
academic referencing	your ability to refer to what others have said in your answer, and credit them for their ideas
Deep dive	your ability to go above and beyond the school curriculum to new areas of knowledge
source analysis	your ability to evaluate sources (e.g. for bias, origin, purpose)
Data interpretation	your ability to discuss the implications of what the numbers show
Active reading	your ability to engage with what you are reading by highlighting and annotating

Where can this subject take me?

Pathways

Studying Biology or Psychology can open the doors to many degrees and careers. It intersects with microbiology, chemistry, physiology, and sociology. Whatever interests you is likely to relate to biology in some way. See a snapshot of where studying Biology and Psychology can take you.

'Transferrable skills' from Geography to a career:

- Research ability
- IT skills
- Teamwork
- Problem solving
- Analytical and critical ability
- Communication skills through presenting, writing and debating
- Time management
- Creativity
- Identifying overcoming challenges

What are some are the 'interdisciplinary' subjects in this course?

Interdisciplinary is a term you will hear used by higher education institutions. It's also how many professionals and academics in the real-world operate: they use multiple subjects, or disciplines, to achieve their work.

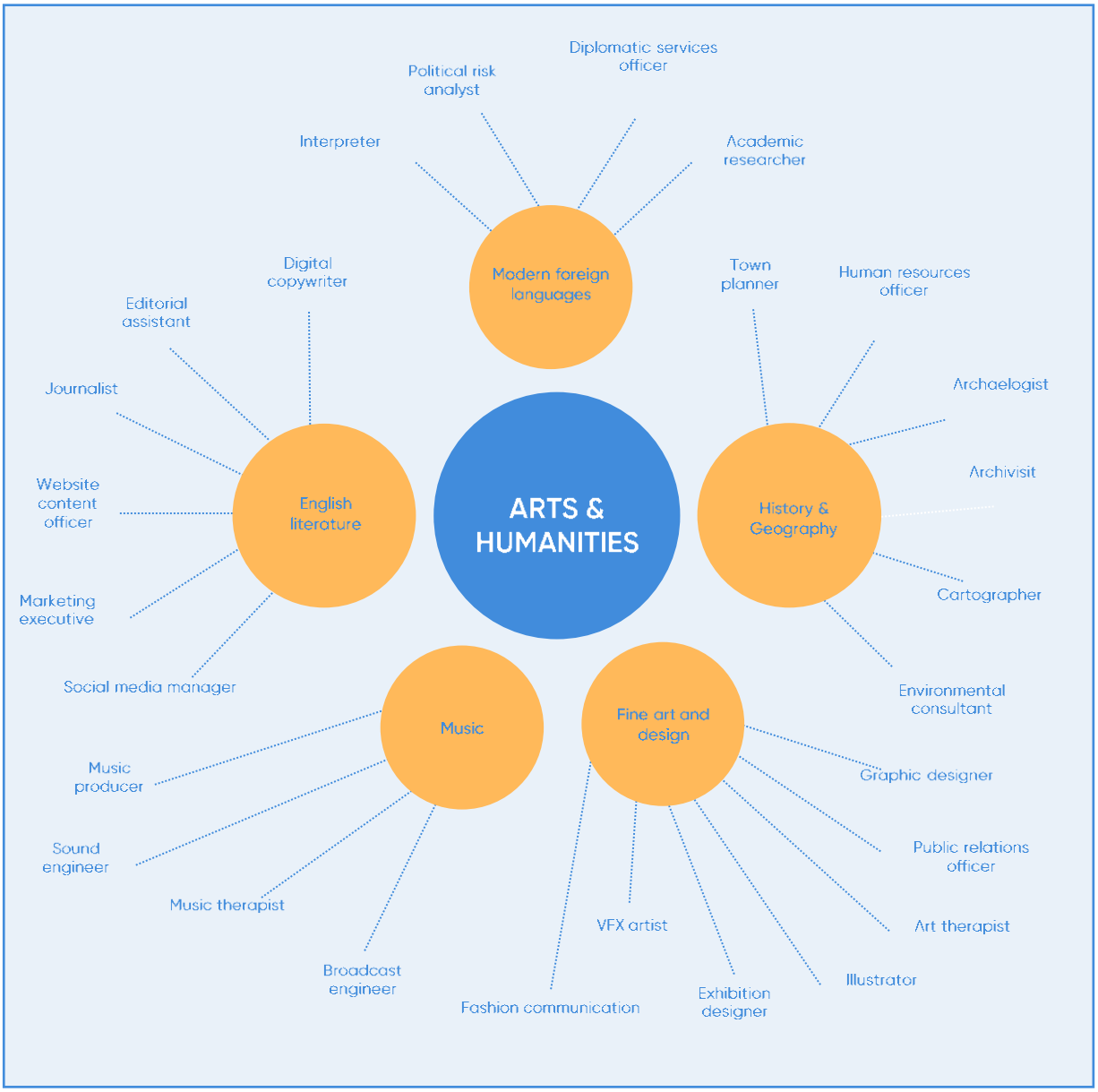
By thinking about which subjects you like, alongside maths, it can help you choose a career pathway later.

Read more about subject selection and careers pathways:

https://targetjobs.co.uk
https://www.prospects.ac.uk
https://thinkuni.org/

Subject map: Arts and Humanities

Arts as a subject choice is quite popular with students, and it doesn't just mean visual arts like painting or design. These subjects often complement one another and around 24.7% of students with an Arts degree go on to do a Masters' degree in a subject that is within the broad field of Arts and Humanities. Furthermore, a lot of these students get jobs in Marketing, PR and sales.



Find our about Science-related careers here:
PROSPECTS: https://www.prospects.ac.uk
TARGET JOBS: https://targetjobs.co.uk

For Teachers RBC Guide

Learner aims

The Research-Based Curriculum aims to support student attainment and university progression by providing classroom resources about cutting-edge research at local universities. The resources are designed to:

- ✓ promote intellectual curiosity through exposure to academic research
- ✓ stretch and challenge students to think deeply about content that may be beyond the confines of the curriculum
- ✓ develop core academic skills, including critical thinking, metacognition, and written and verbal communication
- ✓ inform students about how subjects are studied at university, and provide information, advice and guidance on pursuing subjects at undergraduate level

Content

The programme represents a unique collaboration between universities and schools. Trained by AccessEd, PhD Researchers use their subject expertise to create rich resources that help bring new discoveries and debates to students.

The Research-Based Curriculum offers ten modules suitable for either KS4 or KS5 study. The modules span a range of disciplines, including EBacc and A-level subjects, as well as degree subjects like biochemistry. Each module includes six hours of teaching content, supported by student packs, teacher notes and slides. All modules are available online and free of charge for teachers at select schools.

Using the RBC pack

These resources are designed to be used flexibly by teachers. The resources can be completed by students individually or in groups, in or out of the classroom.

For Teachers
Using the RBC packs

Extra-Curricular Subject Enrichment Clubs

Here are five examples of delivery options:

The resources can be completed in small groups (4-8 pupils) across a series of weekly lunch clubs or after-school clubs. Groups can reflect on their learning by presenting a talk or poster on the subject matter at the end of the course.

University Access Workshops

The resources can be used by students to explore subjects that they are interested in studying at university. This can inform their decision making with regards to university degree courses, and allow students to write more effective personal statements by including reflections on the Research-Based Curriculum.

Research Challenge

The resources can be used to ignite curiosity in new topics and encourage independent research. Schools could hold a research challenge across a class or year group to submit a piece of work based on the resources. Pupils could submit individually or in small groups, with a final celebration event.

Summer Project

Resource packs can function as 'transition' projects over the summer, serving as an introduction to the next level of study between KS3 and KS4, or KS4 and KS5. Students could present their reflections on the experience in a journal.

Why offer these?

The Research-Based Curricula programme builds on the University Learning in Schools programme (ULiS), which was successfully delivered and evaluated through the London Schools Excellence Fund in 2015. The project was designed in a collaboration between Achievement for All and The Brilliant Club, the latter of which is the sister organisation of AccessEd. ULiS resulted in the design and dissemination of 15 schemes of work based on PhD research for teachers and pupils at Key Stage 3. The project was evaluated by LKMCo. Overall, pupils made higher than expected progress and felt more engaged with the subject content. The full evaluation can be found here: ULiS Evaluation.

Questions

For more information contact hello@access-ed.ngo

Introduction to the Topic

Studying Environmental Engineering at University

Studying Environmental Engineering at university is an interesting experience. The subject of environmental engineering is broad and includes studies in geography, environmental science, chemistry, fluid mechanics, engineering, maths and some aspects of business. It is an interdisciplinary course and can either branch out to various topics or diverge to specific topics. It incorporates the study of the physical, chemical and biological processes that take place on Earth as well as the social, political and cultural processes which impact the planet. Understanding the world around us makes students of this subject an ideal advocate for change. Students who complete this course may go on to work as an environmental consultant, environmental educator, environmental engineer, nature conservation officer, sustainability policy advisor and many more. Outside of a career path, the knowledge gained from taking this course gives students the advantage of having enough knowledge to make a change in their community in a more personal capacity.

Introduction to Research

The topics within this pack will include:

Where Does Water Come From

Growing Our Own Food

The Future of Farming

I am currently researching the potential of greywater in hydroponics toward urban agriculture. Greywater is all the wastewater generated in households or office buildings , excluding that which contains fecal contamination, such as from sinks, showers, baths, washing machines or dishwashers. The combination of my education and job experiences have led me into further research in water and food security. In this current climate, the topic of water and food security is a pressing concern which will affect most inhabitants of the world. In my research, I am trying to identify the opportunities that can be contributed by hydroponics to urban agriculture at a small domestic level. I am looking very closely at the chemical loadings of raw and treated greywater and the chemical content in plants that are grown using raw and treated greywater as a main source of water.

Meet the PhD Researcher Anom Ahmad

I grew up into an academic household where both my parents worked at various universities around the world. I grew up on university campuses and was struck by the various opportunities of study a university can offer. I did not follow what many would say is a traditional study trajectory. I studied mechanical engineering, environmental engineering and now I'm doing my PhD research studying water and agriculture. I have had the good fortune to be offered jobs that took me from building schools in the forests of Sabah to building libraries in the city of Kuala Lumpur in Malaysia. I headed a major sustainability project centering around agriculture throughout Malaysia, working with the Malaysian Prime Minister and subsequently with the Minister of Energy and Human Resource in the country of Brunei.

I hope this resource pack will pique your curiosity, lead you to your own discovery of your potential and ultimately take you on life changing adventures.

A-Level Subjects	N/A
Undergraduate	Medical engineering, Environmental engineering
Postgraduate	Water and Agriculture

Glossary

Term	Definition
The Hydrological Cycle	Cycle that involves the continuous circulation of water in the Earth-atmosphere system.
Greywater	Gently used water from your bathroom sinks, showers, tubs, and washing machines.
Urban Farming	Also known as urban agriculture is a way for urban dwellers to grow their own food, or at least have access to local food
Controlled Environment Agriculture	A technology-based approach toward food production aimed at providing protection and maintaining optimal growing conditions throughout the development of a crop.
Hydroponics	Hydroponics is a method of growing plants without soil by instead using mineral nutrient solutions in a water solvent.
Aquaponics	A system of aquaculture in which the waste produced by farmed fish or other aquatic creatures supplies the nutrients for plants grown hydroponically, which in turn purify the water.
Vertical Farming	Vertical farming is the practice of growing crops in vertically stacked layers.
Economic Water Scarcity	water scarcity caused by lack of investment in infrastructure or insufficient human capacity to satisfy the demand of water in areas where the population cannot afford to use an adequate source of water.
Physical Water Scarcity	Physical water scarcity occurs when and where there is not enough water to meet both human demands and those of ecosystems to function effectively.
Hidden Water Usage	This unseen part of your water footprint including the water it took to produce the food you eat and the products you buy

Resource One Overview

Topic	Where Does Water Come From – The Hydrological Cycle (Water Cycle)
A-level Modules	the water cycle, the urban water cycle, sustainable urban water cycle
Objectives	By the end of this resource, you will be able to: ✓ Understand what is meant by 'The Hydrological Cycle' ✓ Understand the difference between the 'Natural' and 'Urban' water cycle
Instructions	1. read the source 2. answer the questions 3. explore the further reading 4. move on to the next resource

Resource One
Data Source

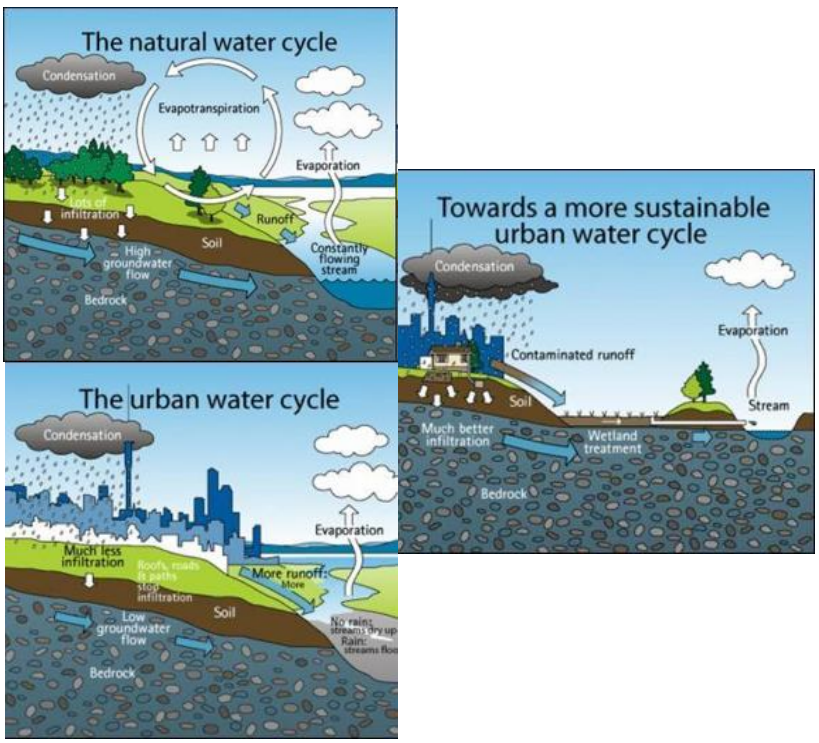
Section A

The Hydrological Cycle

Water is an essential element in a living planet. 97% of earth's water is in our oceans and therefore salty and not suitable for human use. The remaining 3% is freshwater and is found in rivers, lakes, groundwater or in frozen icecaps. Out of that small percentage, less than one 1% is easily accessible for human use. Nature provides a natural cycle for freshwater to be recycled in the natural environment. This cycle can be disrupted through natural causes such as natural disasters, but the main cause of disruption is due to human interruption. The figure below shows three different scenarios of the water cycle. The first one being the natural water cycle with no human interruption, the second is the urban water cycle describes areas of high human activity and the third one is a proposed scenario to maintain a healthy water cycle.

Figure 1

Shows the key differences between the Natural and Urban water cycle and what a sustainable urban water cycle may look like



Active Reading

Resource One
Data Source

Section B

Natural Water Cycle

To fully appreciate the water cycle, we need to understand the terms that come with it. What we can see from the image above is that the water cycle is a closed system, meaning that there is no water added or removed from the cycle at any point. It is the same amount of water throughout the cycle.

We will start at the constantly flowing stream where evaporation happens. When sunlight hits the surface of the water in the stream, it raises the temperature of the water and changes it from liquid to vapor. Evaporation is a process where water turns from liquid to vapor. The water vapor then rises into the atmosphere. The higher it goes into the atmosphere, temperatures drop and turn the water vapor into ice or water droplets. . This process is called condensation. It is what forms clouds and fog in the sky. At the point the air cannot hold any more water, precipitation occurs in the form of rain or snow. As water precipitates, water is absorbed in the soil or by plants.

Active Reading

Water that is absorbed by the soil is called infiltration. It goes deep within the soil and fills up areas in the bedrock beneath the soil. This creates a water network underground known as aquifers, that eventually flows back into the stream. Some of the water from infiltration is absorbed by plants. The water absorbed by plants goes through a process of transpiration. Transpiration is where water absorbed in the plant roots moves to the leaves which in turn changes the water from liquid form to water vapor. It is similar to the evaporation process. Any water that is not absorbed into the soil or to plants, flows across the ground and leads to runoff. The surface water runoff goes back into the stream and the entire process repeats itself.

Resource One
Data Source

Section C

Urban Water Cycle

The natural water cycle concerns the continuous process of condensation, precipitation and evaporation in the environment. The urban water cycle refers to the 'man-made' components created to provide us with drinking water and to remove waste water. The eight steps of the urban water cycle as described by the consulting services firm Short Elliott Hendrickson Inc:

1. Source: The water has to come from somewhere. Often, it comes from surface water like lakes, rivers and reservoirs. But it doesn't have to. Groundwater can also be pumped up via wells.

2. Treatment: Because water taken from open bodies may contain harmful microorganisms, it has to be treated before it reaches us in our homes. This process can involve a lot of steps. Typical surface water treatment involves chemical coagulation, filtration and disinfection.

3. Distribution: After treatment and sufficient disinfection, the water is sent out via a pressurized system of lifts to the areas in the city where it is needed. A disinfectant residual must be maintained at all parts of the system.

4. Storage: After being distributed, the water is stored in water towers before it is used. Water towers use gravity to make sure sure we have the water when and where we need it.

5. Use: We do it every day. We take showers, brush our teeth, water our lawns, clean our clothes and drink water.

6. Collection: Water leaves our homes by going down our drains and toilets. Sewer systems collect and convey the wastewater from our homes and businesses to wastewater treatment plants. The process is typically done using gravity.

Resource One Data Source

7. Treatment: Because the water quality is reduced by usage, and because it has to be put back into the hydrologic cycle, it has to be treated. This is done through a variety of biological and chemical processes.

8. Discharge: Once the treated water (effluent) has been cleaned to regulatory standards, it is discharged back into the environment. When it gets back to the environment, the cycle starts again.

Section D

Sustainable Urban Water Cycle

Sustainability of the urban water cycle is described in the UNESCO publication 'Urban water cycle processes and interactions' by Marsalek, Jimenez-Cisneros, Malmquist, Karamouz, Goldenfum and Chocat:

"Recently, the depletion and degradation of urban water resources has led to the advocacy of a sustainable urban water system, characterised by lower water consumption, preservation of natural drainage, reduced generation of wastewater through water reuse and recycling, advanced water pollution control, and preservation and/or enhancement of the receiving water ecosystem."

Here we focus on three systems to improve drainage. These systems are referred to as SUDS (Sustainable Urban Drainage Systems). From Wikipedia:

Permeable pavement systems aim to provide a manner for water that falls on hardscaping to seep through to the soil below. This is accomplished by either dividing traditional pavement materials into sections, or using a porous pavement material.

Resource One
Data Source

Artificial wetlands can be constructed in areas that see large volumes of storm water surges or runoff. Built to replicate shallow marshes....the ecology of the wetland (soil components, water, vegetation, microbes, sunlight processes, etc.) becomes the primary system to remove pollutants.

Green roofs are landscaped or vegetated areas on the roofs of buildings, usually built to mimic natural landscaping or ground-level parks. Green roofs help drainage systems by offsetting peak discharge from otherwise hardscape surfaces, and filtering rainwater directly as it falls. They also have the added advantage of reducing energy consumption for buildings that would otherwise be receiving direct sunlight onto their roofs throughout the day.

Resource One Activities

Activities

1. List where freshwater is found.
2. What is the difference between evaporation and transpiration?
3. The water cycle is a closed system. What does this imply?
4. Comparing the natural water cycle and the urban water cycle, why is there much less infiltration of water in the urban water cycle?
5. Sketch a flow diagram to illustrate the urban water cycle
6. Explain three ways to improve drainage in the urban water cycle.

Resource One
Further Reading

Explore

- https://science.nasa.gov/earth-science/oceanography/ocean-earth-system/ocean-water-cycle/
- https://www.britannica.com/science/water-cycle

Resource Two Overview

Topic	Water Scarcity – Population, consumption and the degradation of water resources
A-level Modules	The Water Cycle and Water Insecurity

Objectives

By the end of this resource, you will be able to:

- ✓ Understand what is meant by 'Economic' and 'Physical' water scarcity
- ✓ Understand what is meant by 'Direct' and 'Hidden' water usage

Instructions

1. read the source
2. answer the questions
3. explore the further reading
4. move on to the next resource

Resource Two Data Source

Section A

Water Scarcity

Water scarcity is the lack of available water resource in a region. It is a growing global concern and is a priority issue to be addressed by organisations such as the World Economic Forum, United Nations, World Water Council, governments, local councils and the general public alike. Water scarcity is broadly divided into two types: economic and physical.

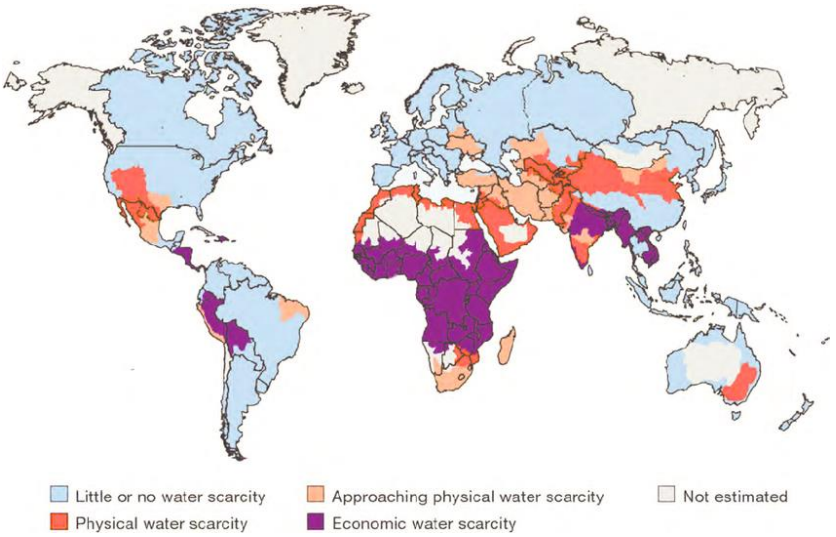


Figure 1

Global distribution of water scarcity showing the key geographical locations affected by Physical and Economic water scarcity. Also shown are regions with little or no water scarcity.

Active Reading

Economic water scarcity is due to a lack of water infrastructure or to the poor management of water resources where infrastructure is in place. It is estimated that more than 1.6 billion people face economic water shortage. In areas with economic water scarcity, there usually is sufficient water to meet human and environmental needs, but access is limited. Mismanagement or underdevelopment may mean that accessible water is polluted or unsanitary for human consumption. Economic water scarcity can also result from unregulated water use for agriculture or industry, often at the expense of the general population

Resource Two
Data Source

Section B

Economic Water Scarcity in Mexico City

"A classic example of this is Mexico City, home to more than 20 million people in its metropolitan area. Although the city receives abundant rainfall, averaging more than 700 mm (27.5 inches) annually, its centuries of urban development mean that most precipitation is lost as contaminated runoff in the sewer system. In addition, elimination of the wetlands and lakes that once surrounded the city means that very little of this precipitation feeds back into local aquifers. Nearly half of the municipal water supply is taken unsustainably from the aquifer system under the city. Withdrawals so greatly exceed the aquifer's renewal that some parts of the region sink up to 40 cm (16 inches) every year. In addition, it is estimated that nearly 40 percent of the city's water is lost through leaks in pipes that have been damaged by earthquakes, by the sinking of the city, and by old age. Many areas, especially poorer neighborhoods, regularly experience water shortages, and water for residents there is routinely brought in by trucks. The historical and modern mismanagement of surface and ground waters and natural areas, coupled with the complexities of being an old but ever-growing city, have made Mexico City one of the top cities threatened by economic water scarcity in the world."

(Taken from: https://www.britannica.com/topic/water-scarcity#ref1265085)

Resource Two Data Source

Section C

Physical Water Scarcity in The Colorado River Basin

Physical water scarcity happens in regions where surface and groundwater resources are inadequate to supply the region's water demands. Around 1.2 billion people live in areas of physical water scarcity. Physical water scarcity can be seasonal where water scarcity can happen at least one month of the year. The number of people affected by physical water scarcity is expected to grow as populations increase.

Over estimation of the amount of annual rainfall and snowmelt runoff, as well as the overallocation of water and the issues posed by rising global temperatures have meant that physical water scarcity has become an emerging issue for those individuals and industries who receive water from the Colorado river.

Active Reading

"Nearly all studies agree that the temperature increases predicted for a changing climate have a large probability of further reducing the water supply of the Colorado River. The Bureau of Reclamation has projected future changes in average annual runoff using an ensemble of 112 climate model runs; the ensemble mean is an 8.5% decrease by 2050. The climatic explanation for this flow reduction lies in a diminished accumulation of high elevation snow during the cool season due to higher average temperatures, which translates into a smaller snowpack and less snowmelt to sustain runoff during the warm season"

Increased evaporation and reduced flow volumes have resulted in an overall increase in water salinity in the Colorado River basin. This has generated major water quality concerns with currently 306 – 312 million dollars per year being spent on salinity control.

Resource Two Data Source

"Today, increased salinity levels are a major water quality concern that threatens agricultural, municipal, and industrial users as well as the River's fish and wildlife populations. The Colorado River's salt content comes from a variety of sources; agriculture alone accounts for 37% of the River's salt. Natural sources such as stream flow, reservoir storage, climatic conditions, and natural runoff account for about 50% of the River's salt.25 Currently, 306–312 million dollars per year are spent on salinity control, and the Bureau of Reclamation estimates that by the year 2025 that number will increase to 471 million dollars per year if no additional projects are put in place."

(Taken from: https://www.coloradocollege.edu/dotAsset/5e9b804b-9bf4-458a-bd30-9095cc05019a.pdf)

Section D

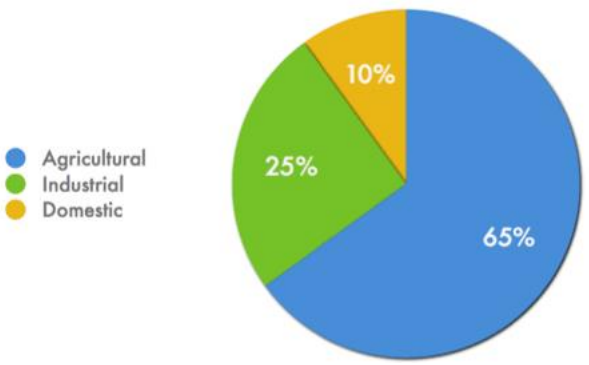
Direct and Hidden Water Usage

Active Reading

Water footprint is the amount of freshwater used by a person, community or business. Water used can be calculated by direct water usage and hidden water usage. Direct water usage, as the term suggest, are water used in activities like drinking water, taking a bath or shower or watering the plants. Hidden water usage is water used to produce products we use or consume such as the amount of water used in processing beef from farm to table. Most people are not aware of their water footprint just from purchasing a pair of jeans, as clothing is not commonly associated with water.

Figure 2

Proportion of global fresh water use attributed to the Domestic, Industrial and Agricultural sectors.



Resource Two Data Source

Table 1

Shows the hidden water usage associated with various forms of agricultural produce such as vegetables, legumes and chicken and bovine meat.

	Litre per kilogram	Litre per kilocalorie	Litre per gram of protein	Litre per gram of fat
Sugar crops	197	0.69	0.0	0.0
Vegetables	322	1.34	26	154
Starchy roots	387	0.47	31	226
Fruits	962	2.09	180	348
Cereals	1644	0.51	21	112
Oil crops	2364	0.81	16	11
Pulses	4055	1.19	19	180
Nuts	9063	3.63	139	47
Milk	1020	1.82	31	33
Eggs	3265	2.29	29	33
Chicken meat	4325	3.00	34	43
Butter	5553	0.72	0.0	6.4
Pig meat	5988	2.15	57	23
Sheep/goat meat	8763	4.25	63	54
Bovine meat	15415	10.19	112	153

A 2010 study (Mekonnen and Hoekstra (2010)) showed that the despite the water footprint of vegetables being high at 322 literes of water per kilogram of produce, the water footprint of Bovine meat (beef) was almost 50 times larger at 15,415 litres of water per Kg of meat produced.

Using this data, we can begin to understand how replacing some of the foods we consume with other products may help us move towards reducing our individual water footprints and potentially move us towards a more sustainable future.

For example: The water usage per gram of protein for milk, eggs and chicken meat is 1.5 times larger than for pulses such as lentils, beans and chickpeas. For beef the water consumption per gram of protein is 6 times larger than that of pulses.

These hidden water usages are another place where growing global populations will drastically increase water withdrawal and potentially facilitate increased water scarcity.

Resource Two Activities

Activities

1. What are the two types of water scarcity?
2. What is hidden water usage?
3. In the global sum of water withdrawal, which sector uses the most water?
4. Describe one way in which a growing population affects water withdrawal?
5. Give one way by which we can reduce our hidden water usage?

Resource Two
Further Reading

Explore

- https://www.unwater.org/water-facts/scarcity/
- https://www.bgs.ac.uk/futureThames/waterSecurity.html

- Mekonnen and Hoekstra (2010) : https://waterfootprint.org/media/downloads/Report-48-WaterFootprint-AnimalProducts-Vol1_1.pdf

Resource Three Overview

Topic	Growing Our Own Food
A-level module	Geography, Food Sustainability

Objectives

After completing this resource, you should be able to:

- ✓ Understand some of the urban agriculture projects being developed globally.
- ✓ Understand what is meant by Controlled Environment Agriculture

Instructions

1. read the source
2. answer the questions
3. explore the further reading
4. move on to the next resource

Resource Three Data Source

Section A

Urban Farming

Agriculture accounts for roughly 70% of freshwater withdrawal globally. Concerns over carbon and water footprints see a surge in interest of sourcing produce locally, which can be constrained by growing urban areas. Alternatively, growing our own food is an option many are deciding to do. Initiatives by communities and local councils in providing allotment plots and managing community gardens are growing especially in urban areas. Commercial agriculture is also popular in urban areas such as through rooftop farming, vertical farming and underground farming. Not all urban farming is a social endeavor, many are for profit and as any other business output and cost play a large role in considering the methods to use in farming. Urban farms can play many roles other than just producing food. Most urban farming programmes incorporate understanding of nutritious eating, how to compost waste and the relationship between farming and the environment. Urban farms can be a good way to utilise unused land in urban areas, improve food security in the community and improve the agriculture processing sector. Examples of successful urban farming programmes around the world are Camp Green (Kampala, Uganda), Ciades Sem Fome (São Paulo, Brazil), City Farm Project (Bangkok, Thailand), Economics and Sustainability (ESTA) (Milan, Italy), Gaza Urban and Peri-Urban Agriculture Project (Gaza) and many more.

Active Reading

Figure 1

An example of an Urban Farming Project in action.

Resource Three Data Source

Section B

Case Study: Camp Green (Kampala, Uganda)

"Harriet Nakabaale runs a small farm called Camp Green in the Kawaala area of Kampala. She collects the plastic bottles discarded by her neighbours. By cutting them, she can use them as flowerpots; by perforating them, they can become watering devices. Nothing goes to waste. Even the shells of the eggs produced by her chickens will be used to grow cress. Kwagala farm has three cows which they feed with banana peel and corn, which is grown using hydroponics, a method of growing plants using a water-based solution instead of soil. Agaba and his colleagues collect the cow dung, which they use to produce fertilizer. Despite the business potential, there are no plans to expand the farm. "We do not need more than three cows," says Abaga. "We are teaching people to keep less but to do more with what they have." An education programme at the farm has trained more than 700 women and young people in urban farming and how to make organic fertiliser and biofuel. Martin Agaba, who works at Kwagala urban farm, says: 'We don't keep more than three cows. We teach people to keep fewer and do more with what they have.' Brian Ndyaguma relies on urban farms in Kampala for a large proportion of his restaurants' vegetables, herbs and fruits. He sees a business opportunity not just for urban dwellers but rural farmers as well. "We still have a big advantage here in Uganda because we have good soil, so food is largely available. The challenge is the distribution." Congestion, lack of refrigerated trucks and long hot days in the markets can make it difficult for the food grown outside of the city to stay fresh. "Urban farming gives rural farmers with more space the opportunity to concentrate on perennial crops, like corn or cereal," he says"

(Taken from Guardian: https://www.theguardian.com/world/2018/sep/19/kampala-uganda-rooftop-farming-vertical-gardening-urbanization)

Resource Three Data Source

Section B

Controlled Environment Agriculture

Urban farming does not come without its shortcomings. Growing plants and rearing meat producing animals need careful considerations such as available water supply, sunlight and temperature. In countries that experience cold seasons, farming may be restricted to growing only certain plants such as lettuce. Most people do not live on a diet of only lettuce nor is it advisable to do so. Similarly, with countries that experience extreme heat and draught.

Active Reading

It is usual for commercial urban agriculture to employ controlled environment agriculture (CEA) methods in greenhouses with controlled climate, humidity, water and light source. This makes growing any type of plants possible as well as rearing different types of animals such as both salt water and freshwater fish in one farm. The figure below shows a type of farming called aquaponics where fish and plants are essential in each other's growth. In an aquaponics system the waste produced by the farming of fish or other aquatic creatures supply the nutrients for the grown of plants. The growing plants then in turn purify the water supply for the fish.

Figure 2

An example of an Aquaponics setup in action

Resource Three Data Source

CEA uses more energy than conventional farming and in turn needs more cost to run. Higher running costs is reflected in the price of the produce which means the produce will then be inaccessible to those who can't afford to buy them.

Other issues in urban agriculture which utilizes the soil it sits on is the problem of soil degradation. In an urban area where surface runoff and pollution are already high, agriculture in urban areas adds more stress to soil. Soil degradation leaves soil unusable for agriculture, changes soil structure and leaks harmful chemicals into groundwater.

Section B

Case Study: Environmental impacts of CEA in Brooklyn, New York, USA

" Commercial CEA Farms on roofs, which rely on the sun as their primary light source, perform well according to measurements of environmental sustainability, while those that use LEDs are not as energy efficient, even when compared to conventional, soil-based farms growing similar items. Community and Institutional Farms that use less capital-intensive lighting have a lower carbon footprint, but questions remain about even their environmental benefits as compared to simpler growing methods. For example, while soil-based rooftop farms such as Brooklyn Grange mitigate urban heat islands and reduce storm water runoff, the same cannot be said of rooftop CEA greenhouses or indoor farms, even ones that use solar arrays. Likewise, while CEA farms use less water, pesticide, and fertilizer than soil-based farms in places such as California there is little evidence that siting Commercial CEA Farms in New York City is necessary, especially when rural and peri-urban ones can accomplish the same more efficiently.

Furthermore, suggesting that locally grown CEA is preferable because it reduces greenhouse gas emissions from long-distance transport is highly dependent on under- lying assumptions (e.g. diesel versus pick-up trucks) and not always supported in reality.

Resource Three Data Source

When referencing extensive studies comparing energy and CO2 emissions for fresh produce imported into New York State compared to the same grown locally, CEA makes most sense in regions with favourable climates where less supplemental heat and light is needed. Beyond that, the environmental advantages begin to shrink.''

Excerpt taken from (Goodman, W. and Minner, J. (2019))

Resource Three Activities

Activities

1. Give one reason why communities are becoming more interested in sourcing local produce?
2. Aquaponics is a popular urban farming technique. Briefly describe what is meant by Aquaponics?
3. List three examples of successful urban farming programmes around the world.
4. In a controlled environment agriculture, what are the elements that are controlled?
5. Why might CEA farming in regions with less favorable climates ultimately be less environmentally advantageous than soil-based farming in regions with favorable climates?

Resource Three Further Reading

Explore

- https://www.cbre.co.uk/research-and-reports/our-cities/urban-agriculture
- https://permaculturenews.org/2014/01/23/harriet-nakabaales-camp-green-uganda/
- https://cidadessemfome.org/en/
- http://www.fao.org/urban-agriculture/en/
- (Goodman, W. and Minner, J., (2019)) - https://www.researchgate.net/publication/330042091

Resource Four Overview

Topic	The Future of Farming?
A-level Modules	Geography, Sustainable Farming

Objectives

After completing this resource, you should be able to:

- ✓ Understand the six basic types of Hydroponics setup
- ✓ Understand the weaknesses of each of the six basic hydroponics setup

Instructions

1. read the source
2. answer the questions
3. explore the further reading

Resource Four Data Source

Section A

Hydroponics

As we have learned, water is an important resource that is dwindling in supply. We also know that agriculture is the sector that uses water the most. Research and technology in farming has been and will continue to be cultivated for many years and many different methods have been created and used with the aim of making farming sustainable. With the human population increasing every year, issues of food and water security is critical.

A very popular method of farming is hydroponics. Hydroponics is planting without the use of soil but instead with nutrient rich water. By taking out the element of soil, growing in a hydroponics system does not contribute to soil degradation and does not require tillage of the soil. Hydroponics also ensures faster growing time and saves water as none is wasted by absorption in the soil. Watering is not required regularly, and a liquid nutrient mix is added in the water which will then be distributed to all the plants instead of putting fertiliser at each plant point.

Active Reading

Because this method does not rely on soil, it means that planting using this method can be used in many locations regardless of soil suitability, slope gradient, indoors or outdoors. This enables planting in car parks, rooftops, or vertically on the side of a building. The flexibility of this system is desirable for urban areas. There are six basic types of hydroponics system which are Wick, Water Culture, Ebb and Flow (Flood & Drain), Drip (recovery or non-recovery), N.F.T. (Nutrient Film Technique) and Aeroponic. It can be a simple system to a fully automated or other complex system according to which variation of hydroponics is used. Below is an overview of each of the 6 basic types of hydroponics system.

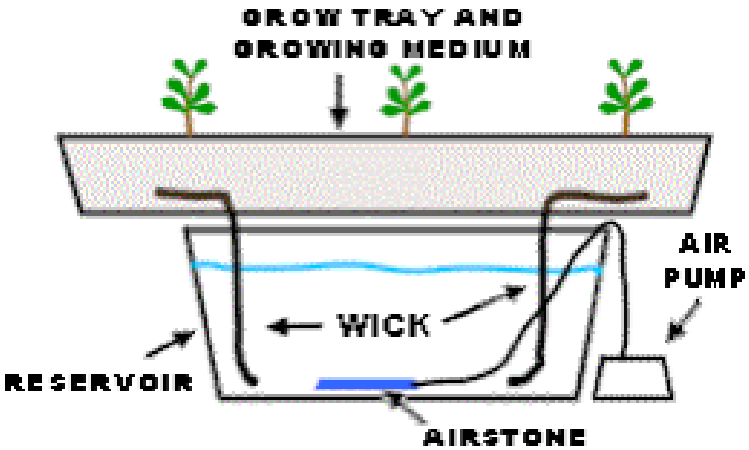
Resource Four Data Source

WICK

The wick system is by far the simplest type of hydroponic system. This is a passive system, which means there are no moving parts. The nutrient solution is drawn into the growing medium from the reservoir with a wick. The biggest drawback of this system is that plants that are large or use large amounts of water may use up the nutrient solution faster than the wick(s) can supply it.

Figure 1

Overview of a wick hydroponics system.



Active Reading

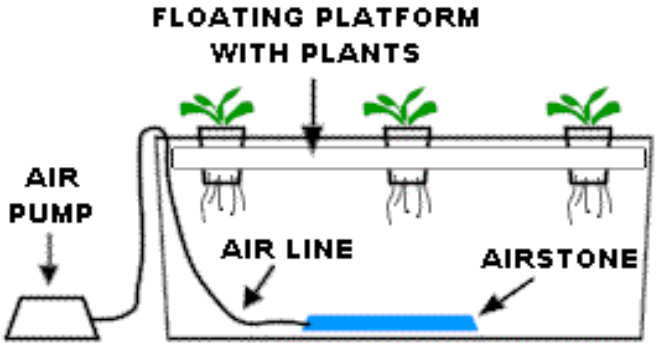
WATER CULTURE

The water culture system is the simplest of all active hydroponic systems. The platform that holds the plants is usually made of Styrofoam and floats directly on the nutrient solution. An air pump supplies air to the air stone that bubbles the nutrient solution and supplies oxygen to the roots of the plants. Water culture is the system of choice for growing leaf lettuce, which are fast growing water loving plants, making them an ideal choice for this type of hydroponic system. Very few plants other than lettuce will do well in this type of system. The biggest drawback of this kind of system is that it doesn't work well with large plants or with long-term plants.

Resource Four Data Source

Figure 2

Overview of a water culture hydroponics system.



EBB & FLOW – (FLOOD AND DRAIN)

The Ebb and Flow system works by temporarily flooding the grow tray with nutrient solution and then draining the solution back into the reservoir. This action is normally done with a submerged pump that is connected to a timer. When the timer turns the pump on nutrient solution is pumped into the grow tray. When the timer shuts the pump off the nutrient solution flows back into the reservoir. The Timer is set to come on several times a day, depending on the size and type of plants, temperature and humidity and the type of growing medium used. The main disadvantage of this system is they are vulnerable to power outages as well as pump and timer failures. The roots can dry out quickly when the watering cycles are interrupted. This problem can be relieved somewhat by using growing media that retains more water.

Resource Four Data Source

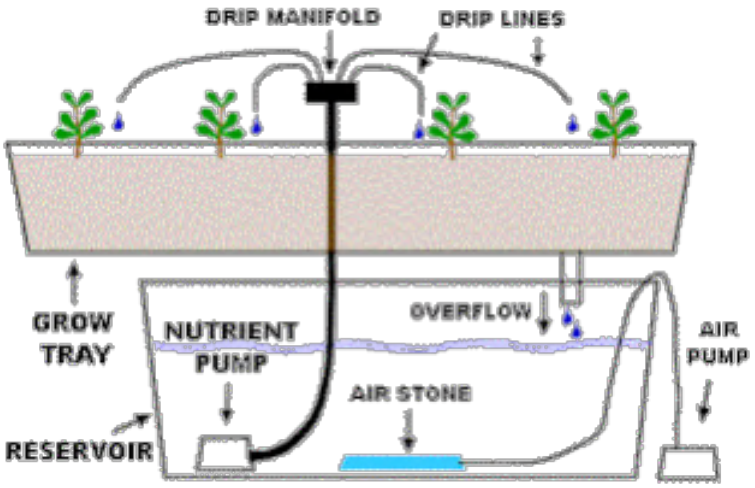
DRIP SYSTEMS: RECOVERY / NON-RECOVERY

Active Reading

Drip systems are probably the most widely used type of hydroponic system in the world. Operation is simple, a timer controls a submersed pump. The timer turns the pump on and nutrient solution is dripped onto the base of each plant by a small drip line. In a Recovery Drip System the excess nutrient solution that runs off is collected back in the reservoir for re-use. The Non-Recovery System does not collect the run off. A recovery system uses nutrient solution a bit more efficiently, as excess solution is reused, this also allows for the use of a more inexpensive timer because a recovery system doesn't require precise control of the watering cycles. The non-recovery system needs to have a more precise timer so that watering cycles can be adjusted to ensure that the plants get enough nutrient solution and the runoff is kept to a minimum. The non-recovery system requires less maintenance due to the fact that the excess nutrient solution isn't recycled back into the reservoir, so the nutrient strength and pH of the reservoir will not vary. This means that you can fill the reservoir with pH adjusted nutrient solution and then forget it until you need to mix more. A recovery system can have large shifts in the pH and nutrient strength levels that require periodic checking and adjusting.

Figure 3

Overview of a drip hydroponics system.



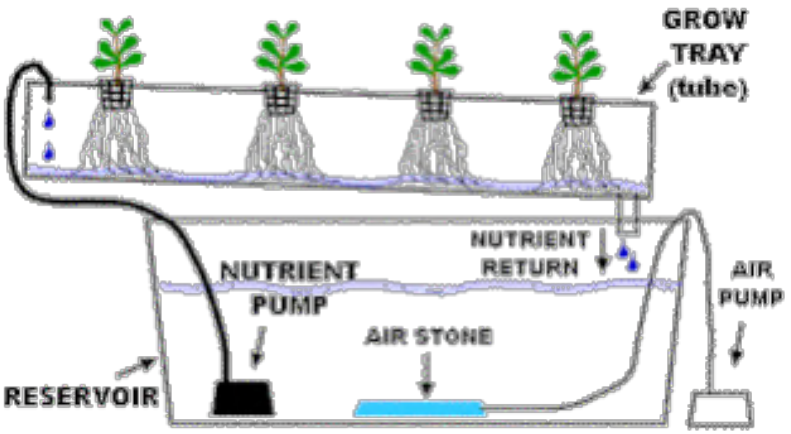
Resource Four Data Source

N.F.T. (Nutrient Film Technique)

This is the kind of hydroponic system most people think of when they think about hydroponics. N.F.T. systems have a constant flow of nutrient solution so no timer required for the submersible pump. The nutrient solution is pumped into the growing tray (usually a tube) and flows over the roots of the plants, and then drains back into the reservoir. There is usually no growing medium used other than air, which saves the expense of replacing the growing medium after every crop. Normally the plant is supported in a small plastic basket with the roots dangling into the nutrient solution. N.F.T. systems are very susceptible to power outages and pump failures. The roots dry out very rapidly when the flow of nutrient solution is interrupted.

Figure 4

Overview of an N.F.T. hydroponics system.



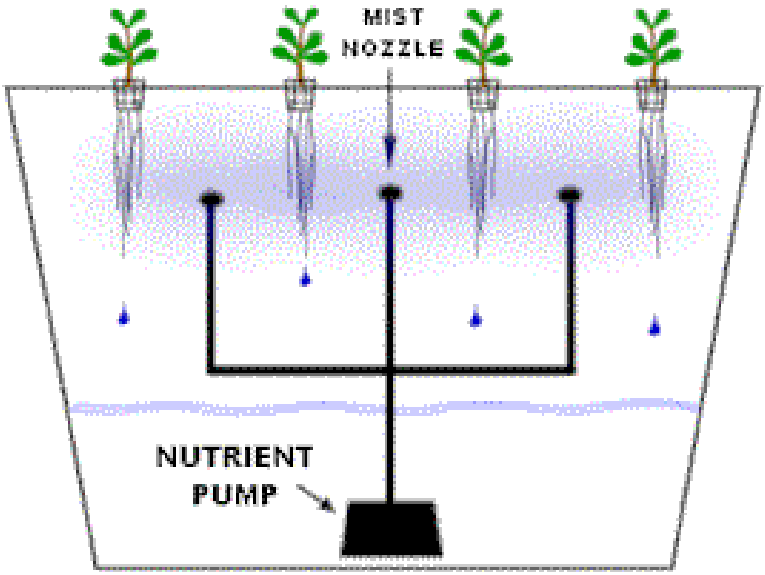
Resource Four Data Source

AEROPONIC

The aeroponic system is probably the most high-tech type of hydroponic gardening. Like the N.F.T. system above the growing medium is primarily air. The roots hang in the air and are misted with nutrient solution. The misting is usually done every few minutes. Because the roots are exposed to the air like the N.F.T. system, the roots will dry out rapidly if the misting cycles are interrupted. A timer controls the nutrient pump much like other types of hydroponic systems, except the aeroponic system needs a short cycle timer that runs the pump for a few seconds every couple of minutes.x

Figure 5

Overview of an Aeroponic hydroponics system.



(Taken from: https://www.simplyhydro.com/system/)

With any other systems, there are also some disadvantages to hydroponics. The biggest disadvantage is the cost of setting it up. It requires pumps, tubes, trays and various other equipment. Finding a balance between cost, methods and output is key to fine tuning hydroponics toward being fully sustainable.

Resource Four Activities

Activities

1. What is hydroponics?
2. What advantage does hydroponics have over conventional planting of plants?
3. How does hydroponics save water?
4. Describe 2 of the 6 basic hydroponics setups? Include the major disadvantages/weaknesses of those you choose to describe.
5. What are some of the biggest disadvantage to hydroponics?

Resource Four
Further Reading

Explore

- https://sustainablefoodtrust.org/articles/vertical-farming-and-hydroponics-on-the-spectrum-of-sustainability/
- https://www.theguardian.com/environment/2019/feb/10/urban-farming-feeding-cities-of-the-future

Resource Five Overview

Topic	Water Recycling – Greywater
A-level Modules	Geography, Water Recycling

Objectives

After completing this resource, you should be able to:

- ✓ Understand what is meant by greywater
- ✓ Understand how greywater recycling could reduce water waste.

Instructions

1. read the source
2. answer the questions
3. explore the further reading
4. move on to the next resource

Resource Five Data Source

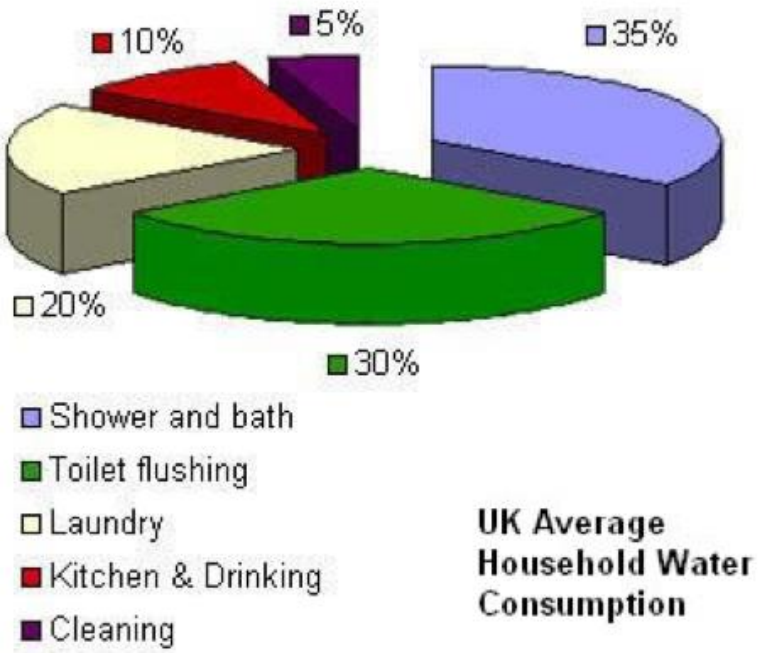
Section A

Greywater

We use water in various ways. Other than for drinking and cooking, we use it to wash things or flush things out. In domestic water use, a lot of water is wasted. We do not know exactly how much water is needed to wash our hands when we run our hands under the tap. Furthermore, the water that goes down the drain after washing our hands isn't very dirty as compared to water from the toilets. Greywater is wastewater from households that does not contain faecal contamination. This means all used water coming from a household except from the toilets. It comes from sinks, showers, baths, dishwashers and washing machines. Greywater makes up 50 to 80% of household wastewater.

Figure 1

Shows the breakdown of the average UK households water consumption.



Resource Five Data Source

Greywater generally contains soaps, bleaches, detergents, shampoo, flavours, fragrances, softeners, preservatives, dyes, solvents, human hair and skin flakes. Greywater can be treated and recycled to be used for toilet flushing and irrigation for plants. This can potentially save up to 70 litres of water per person per day. When collecting greywater, there are a few things to consider. Depending on the household usage, some people collect only from sinks, baths and showers avoiding water from the kitchen sink, washing machine and dishwasher as the contents from these sources most likely have a high loading of chemicals on top of the high possibility of having oil, food and other undesirable content. Collection and storage of greywater must incorporate some level of treatment, as untreated greywater deteriorates rapidly in storage. This rapid deterioration occurs because greywater is often warm and rich in organic matter such as skin particles, hair, soap and detergents. This warm, nutrient-rich water provides ideal conditions for bacteria to multiply, resulting in odour problems and poor water quality. Greywater may also contain harmful bacteria, which could present a health risk without adequate water treatment or with inappropriate use. The risk of inappropriate use is higher where children have access to the water. It is possible to reuse greywater without any treatment provided that the water is not stored for long before use. For example, once bath water has cooled, it can be used directly to water the garden.

Active Reading

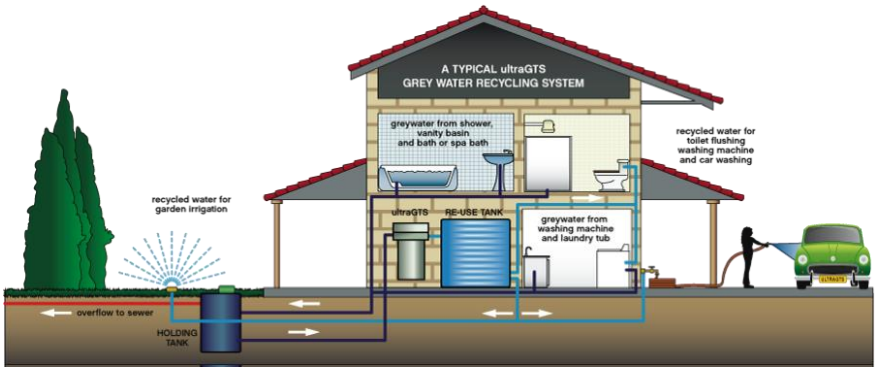
Greywater is nutrient rich and is valuable fertiliser for growing plants. There is a growing interest in using greywater in agriculture with plenty of research being done on the topic. The sustainability of wastewater use in agriculture relies on the assessment and understanding of eight important criteria: health, economic feasibility, social impact and public perception, financial feasibility, environmental impact, market feasibility, institutional feasibility and technical feasibility.

Resource Five Data Source

A similar domestic greywater reuse system as depicted in **figure 2** above was implemented in Jordan as part of an urban grey water reuse project. The case study below describes the background of the project as well as the impact it had on crop growth and the community.

Figure 2

An overview of a basic domestic greywater recycling setup



Section B

Case Study: Greywater Reuse in Jordan

Active Reading

Background: "In 1997, CARE Australia implemented a Permaculture Pilot Project (PPP) at a kindergarten in Ain El Baida, a suburb of Tufileh, Jordan. CARE worked with a community-based NGO, the Ain El Baida Voluntary Society, to demonstrate confined space production techniques for both plants and livestock that conserve soil and water. Many types of fruit trees and vegetables are grown, such as olive, grape, cucumber and tomato. Small animal husbandry includes rabbits, goats, chicken and pigeons. Rooftop rainwater systems and the greywater reuse systems supplement municipal water supplies. At the kindergarten, the greywater is derived from the hand washing of more than 100 children, teachers and staff."

Impact on Crops: "Representative samples of olive tree leaves, tomato plant leaves, and loquat plants were collected. The content of the nitrogen, phosphorus, potassium, magnesium, sodium, chloride, iron and zinc was assessed...

Resource Five
Data Source

Results from the tests have shown that greywater irrigation appeared to have little or no impact on crops. Although the magnesium level was higher and the zinc level lower than optimal for tomato and olive crops, they were still within acceptable ranges. In fact, the variation is attributed to soil conditions and other site-specific reasons, rather than to irrigation water quality. A few families complained about the yellowing of leaves, likely due to residual values of bleach from laundry greywater. On the whole, the impact of greywater irrigation was probably beneficial for most crops, due to the presence of nutrients such as phosphorus, potassium and nitrogen. The exceptions are salt-sensitive crops that are being grown in Ain El Baida including onions, plum, loquat, apple, and pear trees, as well as tomatoes, cucumber, and grapes, which are all moderately sensitive to salt''

Conclusions: ''by adopting greywater reuse, each family in the project area was able to reduce its food expenditures by consuming its garden produce. Some families generated additional income by selling surpluses. These savings are substantial for such poor families — the average family saved or earned 10 percent of its income, while the poorest saved or earned 44 percent. Had the households used municipal sources for this supplemental irrigation, on average, they would have used 15 percent more water and had 27 percent higher water bills. These savings will be enhanced as higher quality greywater is recovered allowing unrestricted irrigation of higher value, faster growing crops, such as vegetables normally eaten raw. Second, there was little evidence of negative health impacts due to greywater irrigation, while positive impacts in terms of improved nutrition are likely. The project has helped improve the home gardening and irrigation skills of the recipients. Furthermore, it has increased the environmental awareness of the community in terms of water conservation and the negative impact of bleach and detergents on soil and food quality.''

Resource Five Activities

Activities

1. What is greywater?
2. How much is the potential of water savings that can be achieved by recycling greywater?
3. Why does stored untreated greywater deteriorate rapidly?
4. What is the breakdown of household water consumption in the average UK household?
5. How is greywater beneficial to agriculture?

Resource Five Further Reading

Explore

- https://sswm.info/sites/default/files/reference_attachments/ENVIRONMENT%20AGENCY%202011%20Greywater%20for%20Domestic%20Users.pdf
- https://www.tandfonline.com/doi/abs/10.1080/02508060208687018

Resource Six Overview

Topic	Urban farming as a Business
GCSE Modules	Geography, Business, Urban Farming

Objectives

After completing this resource, you should be able to:

- ✓ Understand some of the obstacles faced by urban farming ventures
- ✓ Understand some of the advantages urban farming ventures have com pared to traditional rural farming

Instructions

1. read the source
2. answer the questions
3. explore the further reading
4. move on to the next resource

Resource Six Data Source

Section A

Urban Farming as a business

The "Urban Agriculture Europe" EU COST-Action (2012–2016) has shown that the complexity of urban agriculture is hard to fit into classic business management models. Currently urban farming is a popular trend, but it is not yet significantly changing the way we grow and eat. For urban farming to significantly impact our food supply it has to be economically successful.

There is a fierce debate on the profitability and sustainability of commercial urban farming. The concept of a Combined Community Supported Agriculture (CCSA) offering not only fresh vegetables and fruits, but also local sustainable meat and other food produce such as honey understood by many as truly sustainable agriculture. The mark of the CCSA concept's success is when it is able to rival supermarkets and is accessible to the entire community. The current offerings in urban farming are either produced from community gardens, which relies on volunteers and limited resources or commercial urban farms that offer premium products at a high price due to its high operating cost.

Active Reading

One of the biggest obstacles to overcome in order to make an urban farming venture a sustainable business, and the ability to rival supermarkets, is that of scaling. Scaling means the ability to grow the business over time in order to generate more of your product and thus make more money to reinvest back into your business or community. In agriculture scaling usually requires the purchasing of more land on which you can grow your plant products or house your animals. The result is that the increased volume of produce generated allows for lower retail costs. In rural areas is usually scaled in this way through the expansion of the amount of arable land that is used in order to grow produce.

Resource Six Data Source

In areas where individuals have access to large areas of land, agricultural businesses can easily be scaled in order to increase production and turn over profits. In an urban setting, agricultural businesses can often struggle to scale due to the inability to acquire enough city space in order to scale up their production.

Active Reading

One way it has been proposed that urban farming businesses may be able to scale up is by implementing a vertical farming approach. Vertical farming is the practice of growing crops in vertically stacked layers. It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponics. The main advantage of utilizing vertical farming technologies is the increased crop yield that comes with a smaller unit area of land requirement. In general this makes vertical farming a viable option for scaling urban farming businesses.

(Adapted from Wikipedia)

Figure 1

An example of a vertical farming model where plants are grown in using aquaponics in vertical stacked layers.

Resource Six Data Source

Recent studies have also suggested that the productivity (amount of crop yielded) per unit of urban land is nearly twice that which is generated from the same are of rural farming land. An excerpt from this study below goes into more detail.

An extract from a recent study titles 'Small-scale urban agriculture results in high yields but requires judicious management of inputs to achieve sustainability' can be read below (Extract from: McDougall. R., Kristiansen. P. and Rader. R., (2019) PNAS, 116 (1), 129-134.)

''...This study has shown that urban agriculture can be a highly productive use of land, with each square meter put under cultivation equivalent to nearly twice that area of rural farmland and potentially creating the possibility of land sparing. Beyond the ongoing inputs required to carry out farming activity (e. g., labor, materials), urban agriculture comes at very little opportunity cost as it can be used as a way of obtaining productive value from land that would otherwise not be put to effective use. While the inputs required for urban agriculture appear to be high and, in many cases, not sustainable, both of these issues could be mitigated through more judicious sourcing of materials like water and organic matter. These resources are relatively abundant in most urban environments and are often underutilized to the point that they are treated as waste (...) If those inputs were mostly waste products that had no other use, or would create a disposal burden if not used in urban agriculture, then these systems could still be viable. (...) The fact that gardeners are prepared to invest their time in working on urban agriculture projects motivated by social, recreational, and environmental goals over productive ones also suggests that expanding urban agriculture beyond private spaces and controlled public spaces (e.g., community gardens) and into uncontrolled public spaces, such as road verges and park margins, may be viable. (...)

Resource Six Data Source

Future research should examine the economic issues encountered with labor in this study and investigate ways to increase the usage of recycled materials in urban agriculture to improve the sustainability of those systems. If performed correctly, the practice can be carried out with very low environmental impact and cost, and there would thus be few disadvantages in promoting an expansion of urban agriculture."

The extract from study above suggests that the highly productive nature of the land used in urban farming ventures compared to that of land used in rural farming may contribute to increasing the sustainability of urban farming as well as making it a viable business model.

By coupling this with the ideas of vertical farming models, the highly efficient farming technologies of aquaponics and the possibility of including greywater reuse in these urban agriculture projects further contributed to how scalable and sustainable they may be.

Resource Six Activities

Activities

1. What is meant by 'Scaling' with reference to Urban Farming businesses?
2. What are the major obstacles that prevent scaling of Urban Farming Businesses?
3. According to McDougall. R., Kristiansen. P. and Rader. R. what major advantage does urban farming have over traditional rural farming
4. What farming technique could help urban farming businesses become more space efficient?
5. What major advantage does utilising vertical farming have for Urban Farming businesses?

Resource Six
Further Reading

Explore

- https://www.researchgate.net/publication/320233140_Business_models_in_urban_farming_A_comparative_analysis_of_case_studies_from_Spain_Italy_and_Germany
- https://www.epa.gov/sites/production/files/2015-10/documents/1.urban_farm_business_plan_handbook_091511_508.pdf

Final Reflection

Deep Dive

Final task: Make a university style poster summarizing each of the key topics covered in this course.

Your poster should contain poster panels on each of the following

- The Hydrological Cycle
- Economic and Physical water scarcity
- What is meant by Urban agriculture (Include examples of projects currently in practice)
- Hydroponics
- Greywater reuse
- A case study on the success or failure of greywater reuse in urban farming (e.g. The case study of greywater reuse in Jordan found in resource 5)

Your poster should also contain an **introductory** panel introducing the audience to the topic and a **conclusion** summarizing what you have covered in your poster.

Feel free to include any details, including case studies, that you have encountered during independent research.

Part 3 – Study Skills, Tips & Guidance

This section includes helpful tips to help you complete this pack, as well as improve your study skills for any courses you take next year.

It also includes a few fantastic easy-to-use resources to know what to do next if you are hoping to go to university in the next few years, like UCAS advice and web links to more academic opportunities.

In this section:

University Study Skills:

- ✓ Cornell Notes
- ✓ Key Instruction Words
- ✓ Academic Writing
- ✓ Referencing
- ✓ Evaluating Your Sources

University Guidance:

- ✓ What next?

Subject Guidance:

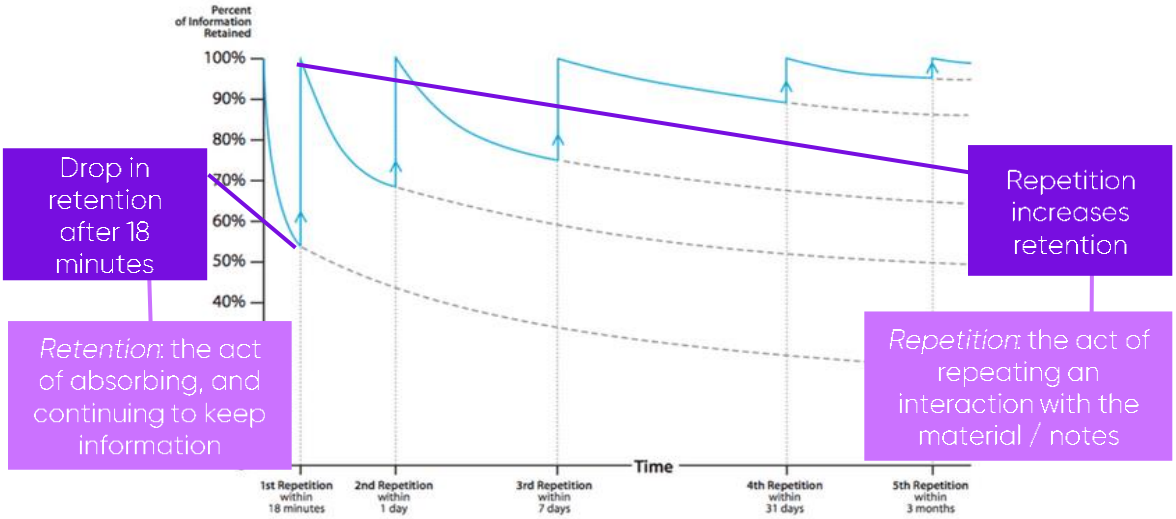
- ✓ More on studying your subject

University Study Skills
Cornell Notes

Why is good note taking important?

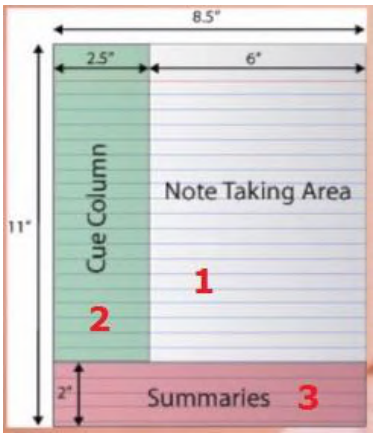
If it feels like you forget new information almost as quickly as you hear it, even if you write it down, that's because we tend to lose almost 40% of new information within the first 24 hours of first reading or hearing it.

If we take notes effectively, however, we can retain and retrieve almost 100% of the information we receive. Consider this graph on the rate of forgetting with study/repetition:



Learning a new system

The Cornell Note System was developed in the 1950s at the University of Cornell in the USA. The system includes interacting with your notes and is suitable for all subjects. There are three steps to the Cornell Note System.



Step 1: Note-Taking

1. Create Format: Notes are set up in the Cornell Way. This means creating 3 boxes like the ones on the left. You should put your name, date, and topic at the top of the page.

2. Write and Organise: You then take your notes in the 'note taking' area on the right side of the page. You should organise these notes by keeping a line or a space between 'chunks' /main ideas of information. You can also use bullet points for lists of information to help organise your notes.

University Study Skills
Cornell Notes

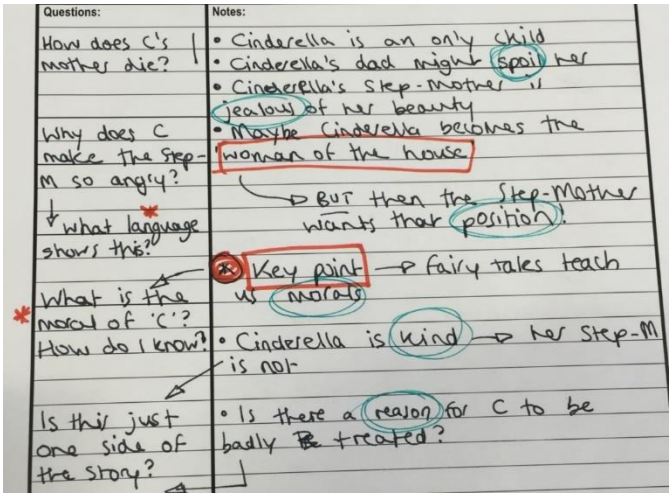
Step 2 Note-Making

1. Revise and Edit Notes: Go back to box 1, the note taking area and spend some time revising and editing. You can do this by: highlighting 'chunks' of information with a number or a colour; circling all key words in a different colour; highlighting main ideas; adding new information in another colour

2. Note Key Idea: Go to box 2 on the left hand side of the page and develop some questions about the main ideas in your notes. The questions should be 'high level'. This means they should encourage you to think deeper about the ideas. Example 'high level' questions would be:

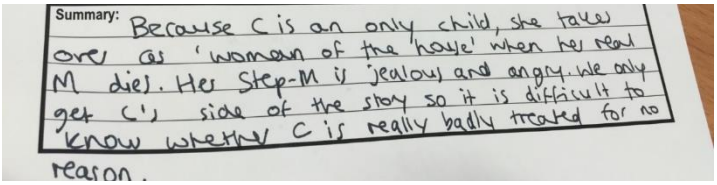
- Which is most important / significant reason for...
- To what extent...
- How does the (data / text / ideas) support the viewpoint?
- How do we know that...

Here is an example of step 1 and step 2 for notes on the story of Cinderella:



Step 3 Note-Interacting

1. Summary: Go to box 3 at the bottom of the page and summarise the main ideas in box 1 and answer the essential questions in box 2.



Give the Cornell Note Taking System a try and see if it works for you!

University Study Skills
Key Instruction Words

These words will often be used when university tutors set you essay questions - it is a good idea to carefully read instruction words before attempting to answer the question.

Analyse – When you analyse something you consider it carefully and in detail in order to understand and explain it. To analyse, identify the main parts or ideas of a subject and examine or interpret the connections between them.

Comment on – When you comment on a subject or the ideas in a subject, you say something that gives your opinion about it or an explanation for it.

Compare – To compare things means to point out the differences or similarities between them. A comparison essay would involve examining qualities/characteristics of a subject and emphasising the similarities and differences.

Contrast – When you contrast two subjects you show how they differ when compared with each other. A contrast essay should emphasise striking differences between two elements.

Compare and contrast – To write a compare and contrast essay you would examine the similarities and differences of two subjects.

Criticise – When you criticise you make judgments about a subject after thinking about it carefully and deeply. Express your judgement with respect to the correctness or merit of the factors under consideration. Give the results of your own analysis and discuss the limitations and contributions of the factors in question. Support your judgement with evidence.

Define – When you define something you show, describe, or state clearly what it is and what it is like, you can also say what its limits are. Do not include details but do include what distinguishes it from the other related things, sometimes by giving examples.

Describe – To describe in an essay requires you to give a detailed account of characteristics, properties or qualities of a subject.

Discuss – To discuss in an essay consider your subject from different points of view. Examine, analyse and present considerations for and against the problem or statement.

University Study Skills
Key Instruction Words

Con't

Evaluate – When you evaluate in an essay, decide on your subject's significance, value, or quality after carefully studying its good and bad features. Use authoritative (e.g. from established authors or theorists in the field) and, to some extent, personal appraisal of both contributions and limitations of the subject. Similar to **assess.**

Illustrate – If asked to illustrate in an essay, explain the points that you are making clearly by using examples, diagrams, statistics etc.

Interpret – In an essay that requires you to interpret, you should translate, solve, give examples, or comment upon the subject and evaluate it in terms of your judgement or reaction. Basically, give an explanation of what your subject means. Similar to **explain.**

Justify – When asked to justify a statement in an essay you should provide the reasons and grounds for the conclusions you draw from the statement. Present your evidence in a form that will convince your reader.

Outline – Outlining requires that you explain ideas, plans, or theories in a general way, without giving all the details. Organise and systematically describe the main points or general principles. Use essential supplementary material, but omit minor details.

Prove – When proving a statement, experiment or theory in an essay, you must confirm or verify it. You are expected to evaluate the material and present experimental evidence and/or logical argument.

Relate – To relate two things, you should state or claim the connection or link between them. Show the relationship by emphasising these connections and associations.

Review – When you review, critically examine, analyse and comment on the major points of a subject in an organised manner

University Study Skills
Academic Writing

What is academic writing?
'Academic writing' is a specific way of writing when communicating research or discussing an argument/point of view. It has a logical structure, and it uses formal language. There is a particular tone, 'voice' and style to the language. Unlike creative or narrative writing, academic writing will also use different sources of information to support what is being said.

The language of academic writing: do's and don'ts

- Do use words you know the meaning of and are confident using, it doesn't have to be complicated to be clear!
- Do not use contractions; don't, can't, doesn't, it'd. Do write out fully; do not, cannot, does not, it would.
- Do not use colloquialisms- this is 'writing as you speak'. Examples include misuse of the words 'literally' or 'basically', common phrases, such 'like chalk and cheese'.
- Do not use slang or jargon. For example, 'awks', 'lit', 'woke'.

Expressing your opinion in academic writing
In academic writing, it is best practice to express an opinion without writing in the first person, which can often be challenging. Always bear in mind that your work should read like a voice that is guided by the evidence and not basic personal intuition.

Therefore, rather than saying 'In my opinion, this proves that', you can express the outcome of your reasoning in other ways:

- 'This indicates that…';
- 'The aforementioned problems in Smith's argument reveal that…';
- 'Such weaknesses ultimately mean that…', and so on.

Signposting
Signposting guides your reader through different sections of your writing. It lets those who read your writing know what is being discussed and why, and when your piece is shifting from one part to another. This is crucial to for clear communication with your audience.

Signposting stems for a paragraph which expands upon a previous idea	Signposting stems for a paragraph which offers a contrasting view
Building on from the idea that … (mention previous idea), this section illustrates that … (introduce your new idea).	However, another angle on this debate suggests that … (introduce your contrasting idea)
To further understand the role of …(your topic or your previous idea) this section explores the idea that … (introduce your new idea)	In contrast to evidence which presents the view that … (mention your previous idea) an alternative perspective illustrates that …
Another line of thought on … (your topic or your previous idea) demonstrates that …	However, not all research shows that … (mention your previous idea). Some evidence agrees that …

University Study Skills
Referencing

What is a reference or referencing?

A reference is just a note in your assignment that tells your reader where particular ideas, information or opinions that you have used from another source has come from. It can be done through 'citations' or a 'bibliography'.

When you get to university, you will need to include references in the assignments that you write. As well as being academic good practice, referencing is very important, because it will help you to avoid plagiarism.

Plagiarism is when you take someone else's work or ideas and pass them off as your own. **Whether plagiarism is deliberate or accidental, the consequences can be severe.** You must be careful to reference your sources correctly.

Why should I reference?

Referencing is important in your work for the following reasons:

- It gives credit to the authors of any sources you have referred to or been influenced by.
- It supports the arguments you make in your assignments.
- It demonstrates the variety of sources you have used.
- It helps to prevent you losing marks, or failing, due to plagiarism.

When should I use a reference?

You should use a reference when you:

- Quote directly from another source.
- Summarise or rephrase another piece of work.
- Include a specific statistic or fact from a source.

University Study Skills
Referencing

Is it a source worth citing?

Question your sources before referencing using these tips:

Currency: the timelines of the information

- When was it published or posted? Has it been revised or updated? Does your topic require current information, or will older sources work as well?

Relevancy: the importance of the information for your needs

- Does the information relate to your topic or answer your question? Who is the intended audience? Have you looked at a variety of sources?

Authority: the source of the information

- Who is the author/publisher/source/sponsor? What are the author's credentials? Is the author qualified to write on the topic?

Accuracy: the reliability and correctness of the source

- Is the information supported by evidence? Has the information been reviewed or refereed? Can you verify whether it is a personal or professional source? Are there errors?

Purpose: the reason the information exists

- Does the author make the intensions/ purpose clear? Is the information fact opinion or propaganda? Are there are biases? Does the viewpoint appear objective?

University Study Skills
Referencing

How do I reference?

- There are a number of different ways of referencing, but most universities use what is called the Harvard Referencing Style. Speak with your tutor about which style they want you to use, because the most important thing is you remain consistent!

- The two main aspects of referencing you need to be aware of are:

1. In-text citations

- These are used when directly quoting a source. They are located in the body of the work, after you have referred to your source in your writing. They contain the surname of the author of the source and the year it was published in brackets.
    - E.g. *Daisy describes her hopes for her infant daughter, stating "I hope she'll be a fool—that's the best thing a girl can be in this world, a beautiful little fool."* ***(Fitzgerald, 2004).***

2. Bibliography

- This is a list of all the sources you have referenced in your assignment. In the bibliography, you list your references by the numbers you have used and include as much information as you have about the reference. The list below gives what should be included for different sources.

- Websites – Author (if possible), *title of the web page*, 'Available at:' website address, [Accessed: date you accessed it].
    - E.g. *'How did so many soldiers survive the trenches?'*, Available at: http://www.bbc.co.uk/guides/z3kgjxs#zg2dtfr [Accessed: 11 July 2019].

- Books – Author surname, author first initial, (year published), *title of book*, publisher
    - E.g. Dubner S. and Levitt, S., (2007) *Freakonomics: A Rogue Economist Explores the Hidden Side of Everything*, Penguin Books

- Articles – Author, *'title of the article'*, where the article comes from (newspaper, journal etc.), date of the article.
    - E.g. Maev Kennedy, *'The lights to go out across the UK to mark First World War's centenary'*, The Guardian Newspaper, 10 July 2014.

University Study Skills
Evaluating your sources

Knowing about the different types of sources and what makes them worth using is important for academic work.

When doing research you will come across a lot of information from different types of sources. How do you decide which source to use? From newspaper articles to books to tweets, this provides a brief description of each type of source, and breaks down the factors to consider when selecting a source.

A platform for millions of very short messages on a variety of topics.

Blogs (e.g. Tumbler) are an avenue for sharing both developed and unpublished ideas and interests with a niche community.

A collection of millions of educational, inspirational, eye-opening and entertaining videos.

A reporting and recording of cultural and political happenings that keeps the general public informed. Opinions and public commentaries can also be included.

A collection of analytics reports that outline the objectives, background, methods, results and limitations of new research written for and by scholars in a niche field.

The information presented is supported by clearly identified sources. Sometimes each chapter has a different author.

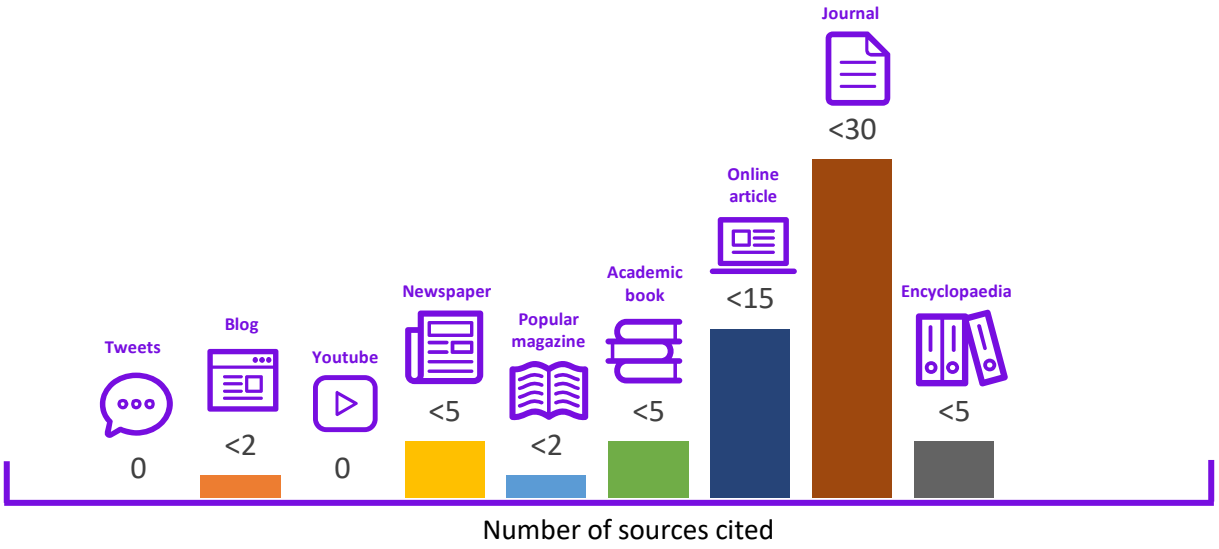
Books or online – giving information on many different subjects. Some are intended as an entry point into research, some provide detailed information and onwards references.

A glossy compilation of stories with unique themes intended for specific interests.

University Study Skills
Evaluating your sources

Number of outside sources

When an author used many outside sources into their writing, they demonstrate familiarity with ideas beyond their own. As more unique viewpoints are pulled into a source, it becomes more comprehensive and reliable. This shows the typical number of outside sources used in each publication.



Degree of review before a source is published

Two factors contribute to the amount of inspection that a source receives before it might be published: the number of reviewers fact-checking the written ideas, and the total time spent by reviewers as they fact-check. The more people involved in the review process and the longer the review process takes, the more credible the source is likely to be.

Number of reviewers	Time in review
0 reviewers	seconds / minutes / minutes
1-2 reviewers	hours / days / days
3-4 reviewers	2-3 months / 6-2 months / 3-5 years

University Guidance
What next?

University Guidance

Different people go to university for different reasons. You might have a particular job in mind or just want to study a subject you are passionate about. Whatever your motivations, going to university can help improve your career prospects, as well as develop your confidence, independence and academic skills.

Choosing a course and university

Choosing the right course to study is an important decision so make sure you take time to research the different options available to you. Here are some top tips:

- ✓ You don't have to choose a course which you have already studied, there are lots of courses which don't require prior knowledge of the subject. You can apply skills gained from school studies to a new field.
- ✓ The same subject can be taught very differently depending on the course and university you choose. Take a look at university websites to find out more about the course content, teaching styles and assessment types.
- ✓ When choosing a university, think about what other factors are important to you. Do you want to study at a campus university or be based in a city centre? What accommodation options are there? Does the university have facilities for any extracurricular activities you're involved in?
- ✓ To research your options, have a look at university prospectuses and websites, as well as seeing if there are opportunities to speak to current students who can give you a real insight in to what life is like there.

Insight into: University of Reading

The author of this coursebook attends the University of Reading.

The University of Reading runs a large number of sessions to help find out more about the process of applying to university as well as taster sessions and Open Online Courses in a number of different subjects. To find out more, visit: www.reading.ac.uk/virtual-events.

Chat to current University of Reading students via Unibuddy and get their views on what university life is like!

University Guidance
What next?

Exploring Careers and Subject Options

- ✓ Find job descriptions, salaries and hours, routes into different careers, and more at https://www.startprofile.com/
- ✓ Research career and study choices, and see videos of those who have pursued various routes at http://www.careerpilot.org.uk/
- ✓ See videos about what it's like to work in different jobs and for different organisations at https://www.careersbox.co.uk/
- ✓ Find out what different degrees could lead to, how to choose the right course for you, and how to apply for courses and student finance at https://www.prospects.ac.uk/
- ✓ Explore job descriptions and career options, and contact careers advisers at https://nationalcareersservice.direct.gov.uk/
- ✓ Discover which subjects and qualifications (not just A levels) lead to different degrees, and what careers these degrees can lead to, at http://www.russellgroup.ac.uk/media/5457/informed-choices-2016.pdf

Comparing Universities

Use our platform ThinkUni.org to take a short quiz about your preferences and interests to find out which universities might be a great fit for you.

Other popular resources:

- ✓ https://www.ucas.com/
- ✓ https://www.whatuni.com/
- ✓ http://unistats.direct.gov.uk/
- ✓ https://www.thecompleteuniversityguide.co.uk/
- ✓ https://www.opendays.com/

University Guidance
What next?

UCAS and the university application process

All applications for UK degree programmes are made through UCAS. There is lots of information on the UCAS website to guide you through the process and what you need to do at each stage.

Apply

- Applications **open in September** the year before you plan to start university.
- You can apply for up to **five courses.**
- The deadline for most courses is **15 January**, though there is an earlier deadline of **15 October** for Oxford and Cambridge, medicine, veterinary medicine/science and dentistry.

Decisions

- Some courses may require an interview, portfolio or admissions test in addition to UCAS application. Check individual university websites details.
- Check UCAS Track which will be updated with decisions from the universities you have applied for and to see your deadline for replying to any offers.
- You should choose a firm (or first) choice university and an insurance choice. If you already have your exam results or a university thinks your application is particularly strong, you might receive an **unconditional offer**.

Results

- If you're holding a conditional offer then you will need to wait until you receive your exam results to have your place confirmed.
- Clearing & Adjustment allows you to apply to courses which still have vacancies if you didn't meet the conditions of your offer, have changed your mind about what or where you want to study, or have met and exceeded the conditions of your offer and would like to look at alternate options.

Personal statements

A really important part of your application is the personal statement. The personal statement gives you the opportunity to tell universities why they should offer you a place.

Here a few top tips for making your personal statement stand out:

- You can only submit one personal statement so it's important that you are consistent in your course choices. Make sure you have done your research to show your understanding of the subject area and passion for it.
- Start by brainstorming all your skills, experience and attributes. Once you have everything written down, you can begin to be selective – you only have 47 lines so won't be able to include everything.
- The ABC method: action, benefit and course can be a useful way to help demonstrate your relevant experience and how it applies to the course you're applying for.

University Guidance
What next?

Personal Statement do's and don'ts

Read the tips below from real life professors and admissions staff in university Biology and Psychology departments, on the 'do's' and 'don'ts' of what to include in your personal statement:

Geography

- Tell us about your adventures in extra reading. We want to know what you have read not on the curriculum and why you have chosen to read them.
- Tell us which aspects of Geography you are interested in
- Are there any issues that you feel strongly about and why? There is always plenty in the news or maybe from personal experience.
- Show you are engaged with the subject. For example, are you involved with any community or conservation groups? What have you learnt from being involved?
- Demonstrate your global and national knowledge. Where have you been, what have you read, what have you learnt?
- Relevant work experience or voluntary work shows that you have passion and drive.

Further useful resources

Be sure you know what you'll need to do to apply to university in the UK:

- ✓ Key dates and deadlines: www.access-ed.ngo/timelines-for-applying-to-university
- ✓ Get tutor advice on writing a UCAS personal statement at www.access-ed.ngo/writing-your-ucas-personal-statement
- ✓ An easy template to start practising your personal statement:https://www.ucas.com/sites/default/files/ucas-personal-statement-worksheet.pdf
- ✓ Untangle UCAS terminology at https://www.ucas.com/corporate/about-us/who-we-are/ucas-terms-explained
- ✓ Discover more about the application process including when to apply and how to fill in your application on the UCAS website.
- ✓ Read more useful advice about what to include in your personal statement on UCAS, the Complete University Guide and The Student Room.
- ✓ Attend one of our virtual sessions to find out more about applying and personal statements.

Subject Guidance

Engineering at University

- ✓ Engineering encompass a broad area of specialist subjects linked to the study of science, maths, and computing.
- ✓ You will learn about cutting edge research working towards developing the technology and infrastructure that makes up the world around us.
- ✓ You can find out more about different courses and entry requirements by exploring the UCAS Engineering Guide online: https://www.ucas.com/undergraduate/subject-guide-list/mechanical-engineering
- ✓ You can find out more about the different careers by exploring the UCAS engineering Careers online: https://www.ucas.com/ucas/after-gcses/find-career-ideas/explore-jobs?f=/job-families/engineering-and-manufacturing

A Deeper look....

- ✓ **Read:** This observer article on urban farming buisnesses – (https://www.theguardian.com/environment/2019/feb/10/urban-farming-feeding-cities-of-the-future)
- ✓ **Watch:** Watch this video on the Vertical farming industry in Tokyo, Japan - (https://youtu.be/pGtdoGXhjxQ)
- ✓ **Do:** Research DIY hydroponics systems: see if you can build one and grow a lettuce or maybe come herbs.....

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