fundisa for change

Teaching **Water**

Geography Grades 10–12

Anisa Khan, Jane Dickinson & Gavin Heath

This is a teacher education text. Its purpose is to expand educators' knowledge of environmental topics to support the teaching thereof in the curriculum. Teachers and teacher educators should consult CAPS documents and textbooks for specific curriculum content, as these units are not a textbook, but rather a resource for teacher education.

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Orientation

Introduction

Why is water important?

Water has been a determining factor for how people have behaved and the choices people have made throughout history, with the early nomads changing their practices by becoming pastoralists close to water sources where they could harness water to produce their own food. This is part of the history of human development. Water continues to be an important factor for development, functioning in some ways as a development issue in terms of the provision of basic human rights to access good quality water and likewise a development issue in terms of the link between the availability of water and economic progress. An understanding of how water is linked to human development, leads us to define development pathways and identify the kind of development that contributes to the well-being of all life on the planet. During the 1980s and 1990s it started to become apparent that the current economic growth model was resulting in development pathways that could not be sustained without serious negative consequences to life supporting systems on the planet (such as the hydrological (water), ecological and atmospheric systems) and to humanity both now (through inequitable development between developed and developing countries) and to future generations. The Brundtland report "Our Common Future" released in 1987 was a response to the rising environmental crisis and called for sustainable development pathways that "would meet the needs of the present without compromising the ability of future generations to meet their own needs". When teaching about water and water issues one can consider this statement in the context of water needs now and in the future within the context of local availability of water and national growth needs.

How these units support teaching and learning about water

These Water units have been written to support you in the teaching of water and water resource management in the Grades 10-12 phase (FET) of the Geography curriculum. The units take a socio-ecological perspective that is focusing on water as it relates to people and the environment. Also important to note is that the CAPS set the minimum requirements for learners; however, these materials are not intended as a learning aid or to replace the textbook but rather to enhance teachers' own professional development by adopting a CAPS++ approach to content in the CAPS.

Water is a cross-cutting theme that would integrate well into the teaching of other concepts in the Geography curriculum such as droughts and desertification, floods, soil erosion, development inequities, climate change impacts on Africa, etc.

These units also aim to support the 4 Big Ideas in Geography (CAPS, p.8), namely: Place; Spatial processes; Spatial distribution patterns and Human-environment interaction.

The broader aims of Geography (as described in CAPS) are also used as the central themes in these units. These include:

- Enabling learners to interpret the physical and human elements and processes of Geography;
- Explaining and understanding inter-relationships between the physical and the human;
- Being able to make critical decisions and informed judgements on issues; and

- Encouraging learners to explore the areas in which they live to understand the importance of water in their lives (close and local).

The activities in the units aim to develop several of the subject-specific skills that are key to the Geography curriculum.

In these three units, we support you as a teacher to:

- Strengthen your subject content knowledge of water issues;
- Enhance your teaching practice; and
- Support your assessment practice.

Water in the CAPS

The FET Geography Water units

The three water units in this Fundisa for Change resource have been developed to expand teachers' knowledge and expertise in ways that also support teaching the CAPS Geography curriculum for Grades 10-12. The sections do not necessarily follow the sequence of the CAPS. The most relevant connections to CAPS topics are indicated at the start of each unit with more details provided at the start of each activity.

The units are:

Unit 1: Water availability
Unit 2: Water and development
Unit 3: Action taking for water management

CAPS links to the Water units

Where possible, the use of geographical skills and techniques has been incorporated into the activities, including the use of orthophoto and topographic maps, aerial photos and GIS.

Teachers should consult the CAPS for specific curriculum content.

Unit 1: Water availability

The first Water unit focuses on the current situation with respect to water availability.

The activities are:

1. Where is the water in South Africa?
2. Water security
3. Factors affecting water quality

Unit 1 related topics within the CAPS, showing relevant grades and terms:

KEY CONCEPTS AND PROCESSES	GRADE	TERM
WATER RESOURCES ***Water in the World*** [2 hours] ◆ different forms of water in the world: liquid, solid and gas; ◆ occurrence of salt water and fresh water: oceans, rivers, lakes, ground water and atmosphere; and ◆ the hydrological cycle. ***Water management in South Africa*** [5 hours] ◆ rivers, lakes and dams in South Africa; ◆ factors influencing the availability of water in South Africa; ◆ challenges of providing free basic water to rural and urban communities in South Africa; ◆ the role of government – initiatives towards securing water: inter-basin transfers and building dams; ◆ role of municipalities: provision and water purification; and ◆ strategies towards sustainable use of water – role of government and individuals.	10	4

GEOMORPHOLOGY ***Drainage systems in South Africa*** ◆ important concepts: drainage basin, catchment area, river system, watershed, tributary, river mouth, source, confluence, water table, surface run-off and groundwater.	12	1

Unit 2: Water and development

The second Water unit focuses on a future perspective of water.

The activities are:

1. Water availability and development patterns
2. Water resources and development
3. The impact of climate change on the water, food, energy nexus

Unit 2 related topics within the CAPS, showing relevant grades and terms:

KEY CONCEPTS AND PROCESSES	GRADE	TERM
THE ATMOSPHERE ***Heating of the atmosphere*** ◆ Greenhouse Effect – impact on people and the environment; ◆ global warming: evidence, causes and consequences, with reference to Africa; ◆ impact of climate and climate change on Africa's environment and people – deserts, droughts, floods and rising sea levels.	10	1
POPULATION ***Population distribution and density*** ◆ meaning of population distribution and population density; ◆ world population density and distribution; and ◆ factors that affect distribution and density of the world's population.	10	3
WATER RESOURCES ***Water management in South Africa*** ◆ rivers, lakes and dams in South Africa; ◆ factors influencing the availability of water in South Africa; ◆ challenges of providing free basic water to rural and urban communities in South Africa; ◆ the role of government – initiatives towards securing water: inter-basin transfers and building dams; ◆ role of municipalities: provision and water purification; and ◆ strategies towards sustainable use of water – role of government and individuals.	10	4
THE ATMOSPHERE ***Africa's weather and climate*** ◆ Africa's climate regions; ◆ reading and interpreting synoptic weather maps. ***Droughts and desertification*** ◆ areas at risk: regional and local scales; ◆ effects of droughts and desertification on people and the environment, such as differences in vulnerability.	11	1
DEVELOPMENT GEOGRAPHY ***Frameworks for development*** [6 hours] ◆ factors that affect development, including: access to resources, energy, history, trade imbalances, population growth, education and training, natural resource limitations and environmental degradation (note: learners need to explore the complexity and interrelated nature of these factors);	11	3

◆ development models: free market models, such as Rostow's model with its limitations and criticisms, core and periphery models with their application at different scales; sustainability models with their economic, social, and environmental elements; and ◆ community based development, including approaches to rural and urban development. ***Development issues and challenges*** [4 hours] ◆ the role of women in development: gender issues related to power, access to resources and attitudes; ◆ the effect of development on the environment; ◆ the role of the state and business in development in South Africa, including central control by the state, weak state control and public private partnerships.	11	3
RESOURCES AND SUSTAINABILITY ***Using resources*** [3 hours] ◆ the relationship between resources and economic development; ◆ exploitation and depletion of resources; and ◆ concepts of sustainability and sustainable use of resources. ***Energy Management in South Africa*** ◆ South Africa's changing energy needs; ◆ energy management, towards greener economies and sustainable life styles: responsibilities of governments, businesses and individuals.	11	4
ECONOMIC GEOGRAPHY OF SOUTH AFRICA ***Agriculture*** ◆ factors that favour and hinder agriculture in South Africa, such as climate, soil, land ownership and trade; ◆ the importance of food security in South Africa – influencing factors; and ◆ case studies related to food security in South Africa.	12	3

Unit 3: Action taking for water management

The third Water unit focuses on an educational response to water availability and water accessibility issues.

The activities are:

1. Why do we need wetlands?
2. Case study: The Orange-Senqu River drainage basin
3. Action taking around water issues in your community

Unit 3 related topics within the CAPS, showing relevant grades and terms:

KEY CONCEPTS AND PROCESSES	GRADE	TERM
WATER RESOURCES ***Water management in South Africa*** ◆ rivers, lakes and dams in South Africa; ◆ factors influencing the availability of water in South Africa; ◆ challenges of providing free basic water to rural and urban communities in South Africa; ◆ the role of government – initiatives towards securing water: inter-basin transfers and building dams; ◆ the role of municipalities: provision and water purification; and ◆ strategies towards sustainable use of water – role of government and individuals.	10	4

RESOURCES AND SUSTAINABILITY ***Using resources*** ◆ the relationship between resources and economic development; ◆ exploitation and depletion of resources; and ◆ concepts of sustainability and sustainable use of resources.	11	4
GEOMORPHOLOGY ***Drainage systems in South Africa*** ◆ important concepts: drainage basin, catchment area, river system, watershed, tributary, river mouth, source, confluence, water table, surface run-off and groundwater; ◆ types of rivers: permanent, periodic, episodic and exotic; ◆ drainage patterns: dendritic, trellis, rectangular, radial, centripetal, deranged and parallel; ◆ drainage density; ◆ use of topographic maps to identify stream order and density; and ◆ discharge of a river: laminar and turbulent flow. ***Fluvial Processes*** [4 hours] ◆ river profiles: transverse profile, longitudinal profile and their relationship to different stages of a river; ◆ identification and description of fluvial landforms: meanders, oxbow lakes, braided streams, floodplain, natural leveé, waterfall, rapids and delta; ◆ river grading; ◆ rejuvenation of rivers: reasons and resultant features, such as knick point, terraces and incised meanders; ◆ river capture (stream piracy): the concepts of abstraction and river capture; features associated with river capture (captor stream, captured stream, misfit stream, elbow of capture, wind gap); and superimposed and antecedent drainage patterns. ***Catchment and river management*** ◆ importance of managing drainage basins and catchment areas; ◆ impact of people on drainage basins and catchment areas; and ◆ case study of one catchment area management strategy in South Africa.	12	1

Key concepts

A number of key ideas or concepts are especially important when teaching and learning about water issues.

The hydrological cycle or water cycle:
The water cycle or hydrological cycle describes the continuous movement of water on, above and below the surface of the Earth. The mass of water on Earth remains fairly constant over time but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables. The water moves from one reservoir to another, such as from river to ocean, or from the ocean to the atmosphere, by the physical processes of evaporation, condensation, precipitation, infiltration, runoff, and subsurface flow. In so doing, the water goes through different phases: liquid, solid (ice), and gas (vapour). Water is also involved in reshaping the geological features of the Earth, through processes including erosion and sedimentation.

Catchment/ drainage basin:
This is the area from which any rainfall will drain into a watercourse through surface flow to a common point. A catchment is the basic unit of the landscape that is often used to explain how the different components (terrestrial and aquatic ecosystems) of the hydrological cycle interact.

Integrated Catchment Management:
ICM refers to the management of all the components of the water cycle that operate within a catchment as well as the human activities that impact on and are impacted upon by the different components of the hydrological cycle (Parry-Davies, 2012).

Ramsar Convention on Wetlands:
This is an intergovernmental treaty signed in Ramsar, Iran, in 1971, which provides a framework for cooperation towards the protection and conservation of wetlands. Signatories are obligated to: identify at least one wetland of international importance; formulate and implement planning to promote wise use of wetlands, establish nature reserves on wetlands and engage in international cooperation with other countries to protect these. The convention has been ratified by 146 countries (including South Africa).

Aquifer:
The National Water Act (Act 36 of 1998) defines an aquifer as “a geological formation which has structures or textures that hold water or permit appreciable water movement through them” that is, an underground formation of permeable rock or loose material which can produce or store quantities of water. Aquifers may be small, only a few hectares in area, or very large, underlying thousands of square kilometres of the Earth’s surface.

Groundwater:
Groundwater is an important part of the water cycle. It comes from rain, snow, sleet and hail that move down into aquifers under the ground because of gravity, passing between particles of soil, sand, gravel, or rock, until it reaches a depth where the ground is saturated, with water, i.e. reaches the water table. Plants may tap into groundwater with their roots and animals may drink it when it comes to the surface as springs. Under natural conditions, water in aquifers is brought to the surface through a spring or can be discharged into lakes, streams, wetlands or the oceans. Groundwater is abstracted through boreholes drilled into the aquifer and then pumped out.

The National Water Act:
The National Water Act (Act 36 of 1998) was established to ensure that freshwater reserves have been set aside for human consumption as well as a sufficient allocation to ensure the proper functioning of healthy ecosystems (DWA, 1998).

Eutrophication:
Eutrophication is the process of over-fertilisation of a body of water by nutrients that produce more organic matter than the self purification reactions can overcome. This occurs as the result of increased concentrations of dissolved nitrates and phosphates from industrial effluent, sewage and run-off from agriculture/ croplands higher up in the catchment.

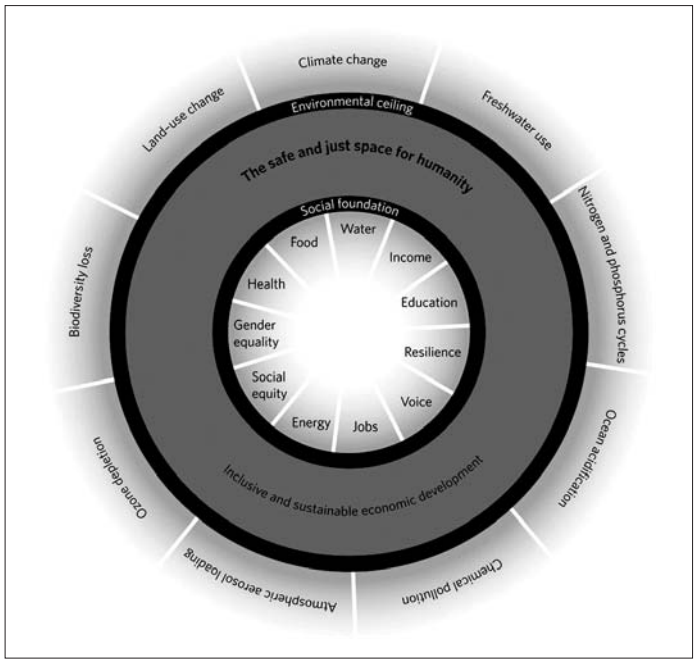
Water, development and sustainability:
The Sustainable Development discourse has been heavily criticised with some critics saying that it is an unattainable goal, similar to achieving World peace, with others equally critical on the basis of a possible "first world" agenda to control growth and progress in developing countries. Whether these arguments have any basis is less significant if one is to consider the latest AR5 IPCC Climate Change report (2013) as well as the Millennium Ecosystem Assessment Reports (2012) all of which provide clear evidence of the negative impacts that our current development trajectories or "growth without limits" are having on the planet.

Please refer to these reports for details: http://ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf and http://www.millenniumassessment.org/en/index.html

Water as a development issue can also be considered from the perspective of "Development as Freedom", or the capabilities approach to development (Sen, 2007) where the capabilities of people can only be realised when they have access to (and mechanisms are put in place to ensure that people are able to) fully realise their needs. Access to clean and safe drinking water is essential to the functioning of people and for people to realise their freedoms.

Access to fresh water:
Global freshwater use is described by the Stockholm Resilience Centre as one of the nine 'planetary boundaries' (Rockstrom, 2011) which create a "safe operating space for humanity". Once these boundaries are surpassed through misuse and mismanagement as well as through climatic shifts, we could reach sudden "tipping points" where sudden and major shifts in the ecological and hydrological system could occur.

Figure 1: A safe and just space for humanity to thrive in



Source: Raworth, K. 2012. 'A Safe and Just Space for Humanity',Oxfam Discussion Paper, February 2012, Figure 1, page 4, as developed by Rockstrom, 2009. http://www.oxfam.org/sites/www.oxfam.org/files/dp-a-safe-and-just-space-for-humanity-130212-en.pdf, accessed 8 May 2014.

The Aral sea in Kazakhstan, formerly one of the four largest lakes in the world with an area of 68 000 km² and supporting many different communities, has almost completely dried up due to Soviet irrigation projects upstream, with the remaining water being heavily polluted.

In KwaZulu-Natal, 7 million people rely on Midmar Dam and the Umgeni River as a safe drinking water source. But Midmar Dam's lifespan is under serious threat from nutrient loading higher up in the catchment as a result of agriculture related economic activities.

A systems approach to understanding water:
Due to the need to understand water and water issues in a more holistic, socio-ecological way, teaching water will require that

you have strong foundational knowledge of water and concepts that deal with water, water management and water choices. A holistic pedagogical (methods) approach is also needed: water needs to be linked to other key issues. This is what is referred to as adopting a systems approach, not to be confused with a systems approach to understanding, for example, climate change where this is referring to the Earth and other systems (eg. hydrological). This is also referred to as the nexus approach, in particular the 'Water, Energy and Food Nexus'. This nexus or the "three pillars of global prosperity" are influenced by two key driving factors, namely population growth and climatic changes (Simonovic, 2013). The water, energy and food nexus functions as a system that is either influenced by or impacts upon the other two systems, for example, available fresh water is impacted by energy use and agricultural demand for food production and likewise, the energy system requires water in order to produce food. These are not the only ways in which these systems interact and it is important to consider that there are also various feedback loops between these systems which require a more in-depth analysis and understanding than can be developed in this unit.

Water supply is a closed system:
The fact that water resources are a closed system means that how we handle our water supply is of utmost importance, and, since water is essential to most life on our planet, the quality of our water is a critical element to achieving sustainability.

Water pollution:
Water is also one of our more fragile resources, with the death of two million people yearly worldwide attributed to water pollution and a lack of safe drinking water. In the developing world, most sewage goes directly into the water supply untreated, and tainted water is responsible for roughly 80% of illnesses in poorer countries. In the developed world, pollution from industry, roads and agriculture has a huge impact on the quality of our water supply.

One drop of motor oil is capable of contaminating one million drops of water.

Unit 1

Water availability

This Fundisa for Change unit focuses on the current situation with respect to water availability in South Africa and the rest of the world.

The key questions addressed by this unit are:

- How much water do we have?
- What factors impact on the amount of water we have available?
- How can we ensure that our available water retains a high quality?

Opportunities arise for discussing these questions as part of the CAPS topics listed in the table below.

KEY CONCEPTS AND PROCESSES	GRADE	TERM
WATER RESOURCES ***Water in the World*** [2 hours] ◆ different forms of water in the world: liquid, solid and gas; ◆ occurrence of salt water and fresh water: oceans, rivers, lakes, ground water and atmosphere; and ◆ the hydrological cycle. ***Water management in South Africa*** [5 hours] ◆ rivers, lakes and dams in South Africa; ◆ factors influencing the availability of water in South Africa; ◆ challenges of providing free basic water to rural and urban communities in South Africa; ◆ the role of government – initiatives towards securing water: inter-basin transfers and building dams; ◆ role of municipalities: provision and water purification; and ◆ strategies towards sustainable use of water – role of government and individuals.	10	4
GEOMORPHOLOGY ***Drainage systems in South Africa*** ◆ important concepts: drainage basin, catchment area, river system, watershed, tributary, river mouth, source, confluence, water table, surface run-off and groundwater.	12	1

Subject Content Knowledge

Introduction

South Africans have varying experiences of water availability. People who live on the eastern half of South Africa may not at first realise that South Africa is a water scarce country. But if rainfall and water availability is averaged across South Africa, our country's mean annual rainfall levels are far below that of many other countries and we are in fact classified by the UN as a water scarce country!

This unit provides teachers with an overview of where most of the water that is consumed in South Africa comes from. This unit relates water in the world to water availability for human use and will assist you in understanding water resources from the perspective of water management in South Africa and how the availability of water and changes to the hydrological cycle are being caused through human activity.

Summary of subject content knowledge

Water availablility in South Africa

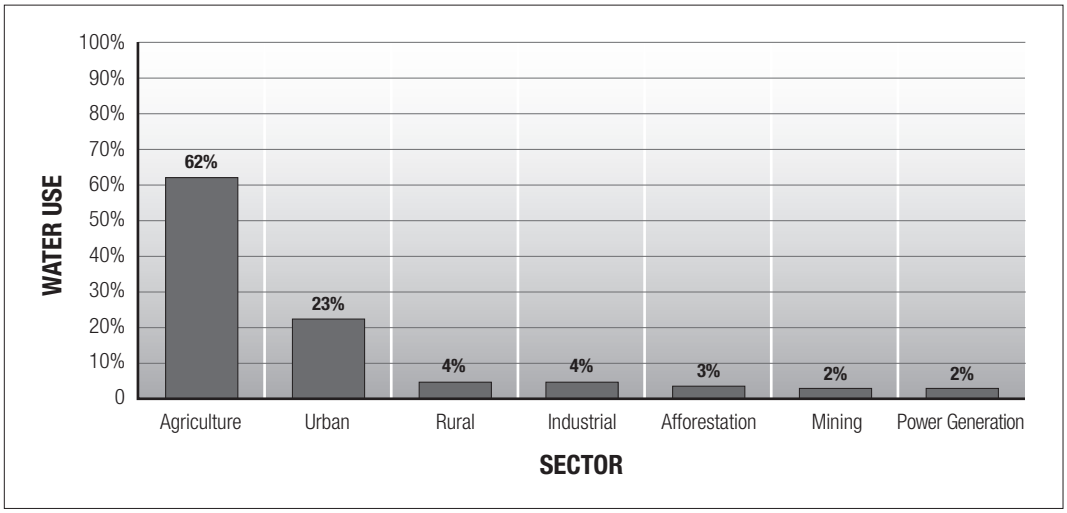
South Africa has low levels of rainfall relative to the world average, with high variability and high levels of evaporation due to the hot climate, and increasing challenges from water pollution. South Africa is the 30th driest country in the world and has less water per person than countries widely considered much drier, such as Namibia and Botswana (NWRS, 2013). As we have a limited quantity of available freshwater resources in South Africa we need to be particularly careful as to how we manage and utilise these resources, especially if one considers that "most of our major rivers have already been dammed; 50% of our wetlands have been lost; industrial and domestic pollution is increasing; and an estimated overall increase in demand of some 52% over the next 30 years is predicted (due to increased population and increased demand from economic sectors)'' (DEAT, 1999).

Water availability is dependent on processes that take place along the different phases of the water cycle, for example, higher sea surface temperatures (as a result of climate change – see IPCC report, 2013) affect rates of evaporation and cloud formation over the sea and may cause changes and shifts in the hydrological cycle over particular areas, thereby affecting the availability of water. More latent heat in the atmosphere can also result in more severe weather events and high intensity rainfall events which results in more soil erosion and rivers that carry a higher siltation load. This siltation load also has a negative effect on the storage capacity of dams, thus resulting in less water available for human use.

Some other factors negatively affecting water availability in South Africa are:

- Invasive Alien Plants (water hyacinth affects the capacity of dams and rivers in terms of water storage. IAPs also need much more water than indigenous trees for growth and may affect groundwater levels).
- Because of forestry, sugar-cane and alien invasive plants, only 9% of the rainfall reaches our rivers. (The world average is 31%.)
- The population is growing every year and more people need water.

- The individual water needs of each person are also growing as people strive for a higher standard of living and more consumer goods.
- Further industrial growth is being encouraged to raise levels of employment and wealth. The new factories that are built will need more water too.
- Available freshwater is being contaminated, rendering it unusable, for example by Acid Mine Drainage and other chemical pollutants.
- The lifespan of dams are being drastically reduced due to increased agricultural production along water courses resulting in higher nutrient loads, leading to the eutrophication of dams and higher siltation levels.
- South Africa's total water requirements are growing by about 4% a year. Our water demand is expected to double between 2005 and 2030 and may pose a risk of available water 'running out' by 2030.



Source: Adapted from DWAF, 2009.

Expanding knowledge

The following hyperlinks are to interesting websites that present relevant information in an understandable way.

Hyperlinks

http://www.fao.org/docrep/003/x9419e/x9419e08.htm – Case study: South Africa contains many useful tables regarding water availability and management as well as future projections of usage.

http://www.dwaf.gov.za/iwqs/gis_data/river/rivs500map.html – a useful GIS resource which allows you to view the drainage basins of Southern Africa in detail.

http://www.rvatlas.org – The South African Risk and Vulnerability Atlas provides a good explanation of seasonal variations in precipitation and the link between temperature variations, weather systems and changing rainfall patterns.

http://www.enviropaedia.com/topic/default.php?topic_id=240 – The Enviropaedia: Rethinking Reality (Water topic) has easy to read and well-presented information on water issues.

Teaching Practice

In this section, we present a variety of ways in which you can teach learners about water availability and accessibility in South Africa. The aim is not to provide a predetermined set of activities that you can use in your classroom. Instead, we will be working with you to help you integrate different methods of learning into your classroom practice depending on which knowledge and skills you aim to develop in your learners.

Skills cannot be learnt through reading a textbook or a worksheet. Skills development requires an opportunity to think and practise learning in different ways. This means that we need to think creatively about different ways of teaching that will help us to give learners the opportunity to develop these skills while they are learning about water in South Africa.

Learning occurs in various ways. Shallow or surface learning is usually associated with factual recall. Deeper learning usually requires a learner to test the information being received against a required value system, belief system and also to enable a learner to question assumptions. This type of learning is not easy and requires a creative teacher and facilitator and a receptive learner.

ACTIVITY 1

WHERE IS THE WATER IN SOUTH AFRICA?

In this activity, map work is used for learning purposes and practising enquiry. The activity aims to develop learners' mapping skills and to provide a spatial orientation to where the major rivers and dams in South Africa are located as well as to develop research skills related to learning and understanding the context of the issue of water availability in South Africa.

Method used: Information transfer method

See page 11 in the *Methods and Processes* booklet.

Learners are engaged in a number of tasks where they translate information from one form to another, drawing on prior knowledge and attitudes to the natural environment to construct the knowledge into new forms.

Links to CAPS

This activity helps to develop the following knowledge and skills as described in the CAPS:

- Using verbal, qualitative and symbolic data forms such as text, pictures, graphs tables, diagrams and maps;
- Practising field observation and mapping, interviewing people, interpreting sources and working with statistics;
- Processing, interpreting and evaluating data;
- Using atlases; and
- Geographical Information Systems.

The CAPS topics that link directly to this activity are the Grade 10, Term 4 topics of Water Resources: Water in the World and Water management in South Africa and the Grade 12, Term 1 topic of Geomorphology: Drainage systems in South Africa.

Core knowledge

South Africa is a water scarce country

Water is unevenly distributed across South Africa and it is drier on the western half of the country.

Surface water and river flow

Surface water accounts for 77% of all available and utilised freshwater in South Africa (rivers, dams and lakes) and also impacts on available groundwater.

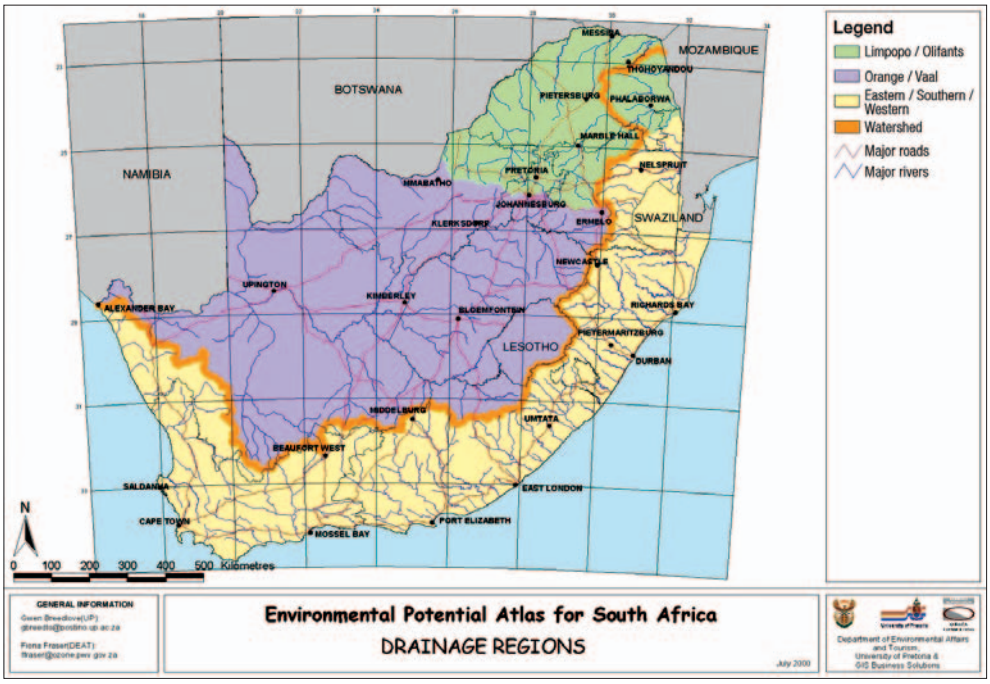
River systems include the entire length of the main channel, from source (headwaters) to the sea, and associated permanent or temporary wetlands (floodplains, lakes, pools, estuaries, and deltas). These components of the river system and the surrounding landscape it drains (its watershed), are interconnected and interdependent making river basins a convenient and logical unit for managing most environmental systems (Beekman et al., 2009). Approximately 25% of the mean annual runoff in South Africa needs to remain in rivers and estuaries to support ecological functioning of catchments (NWRS, DWA, 2013).

The following websites have information specific to particular catchment areas/rivers:

http://www.ngo.grida.no/soesa/nsoer/issues/water/state2.htm National State of the Environment Report – Freshwater Systems and Resources

http://www.dwaf.gov.za/WFGD/documents/WfGDv6Nov21.pdf Water for Growth and Development in South Africa, Department of Water Affairs and Forestry.

The drainage network of South Africa can be divided into four major systems:



Source: Dept of Environmental Affairs and Tourism, University of Pretoria and GIS Business Solutions, 2000.

- Approximately 48% of the country (606 000 km^2) is drained into the Atlantic Ocean by the Orange-Senqu River, which rises in the Lesotho Highlands, and its tributaries. The main tributaries are the Caledon and the Vaal Rivers.
- North of the Witwatersrand ridge, the plateau is drained to the Indian Ocean by the Limpopo system, with major tributaries such as the Crocodile and the Olifants Rivers. This basin drains approximately 14% of the country.
- All other rivers drain into the Indian Ocean, the largest of which is the Tugela River, which covers approximately 29% of the country.
- Rivers draining the Cape Fold Mountains of the south-western Cape into the Atlantic and Indian Oceans cover approximately 9% of the total land surface area. The most important rivers in this area are the Olifants, Berg and the Breede Rivers.

Rainfall in South Africa

South Africa receives an average of only 500mm of rain a year. 65% of the country gets less than 500mm. As a result, freshwater is unevenly distributed across the country and water has to be moved from areas of availability to areas of less availability, through very expensive water inter-basin transfer schemes.

Water availability is limited in South Africa for the following geographical reasons:

- South Africa has a low average annual rainfall.
- Most of South Africa's rainfall is concentrated in the east of the country.
- Coastal regions receive more rainfall than plateau regions along the same lines of latitude, for example the east coast of South Africa receives over 1000mm per year whereas Gauteng, the province with the greatest water demand, receives only 668mm.
- 86% of the country experiences winter drought.
- Both summer and winter rainfall regions receive 80% of their annual rainfall in only five months of the year.

Outline of activity

The activity could be used in combination with a fieldwork activity if you are close to any of the major rivers identified or close to a dam. However, in this activity the tools of fieldwork are being stressed, namely map based research and gaining a spatial perspective. This can either be an atlas activity or, if your school has access to computers and GIS software, can be incorporated in a lesson used to orientate learners to the use of GIS data layers which could include all the major rivers in South Africa.

Learners each receive a map of South Africa with rivers and catchment areas marked, but minimal text, such as the map below.

1. Using their atlas, learners locate and label the following rivers and dams:

   Major rivers that flow to the west coast (i.e. Atlantic Ocean) and some associated dams

   1. Orange/Gariep (including Vaal, Harts, Caledon and Senqu Rivers) and the Vanderkloof, Gariep, Vaal, Bloemhof and Katse Dams

2. Olifants River (western Cape) and the Clanwilliam Dam
3. Berg River and new Skuifraam Dam

Major rivers that flow out to the east coast (i.e. Indian Ocean)

1. Breede
2. Gouritz
3. Gamtoos
4. Sundays
5. Fish
6. Great Kei
7. Umzimbuvu
8. Umzimkulu
9. Tugela
10. Umfolozi
11. Pongola with Pongolapoort Dam
12. Komati
13. Olifants
14. Limpopo

2. Learners create a key to the catchment areas and use coloured shading to distinguish the seven catchment areas.
3. Ask learners to look at the rainfall map for South Africa in their atlases. Now draw in a line on their water catchment map that would be down the middle of the 401-600mm rainfall area so that they can identify the 500mm isohyet line. This is an important line and splits the country into a **drier** western half and a **wetter** eastern half.
4. Identify the catchment area that you live in. Research the rivers that flow in your catchment area, the volume of water they provide, the size of their drainage basins, the number of dams they have, etc. Research the source of the water used in the area in which you live.

Assessment

The final map would be assessed using a memorandum.

The research page could be assessed using a rubric.

Developing your teaching practice

Working in pairs discuss the activity above and provide suggestions on how this can be further improved. Also discuss the grade level this activity would be most appropriate for and the time that would be required in order to do the lesson. List any possible challenges and how these could be overcome.

If you are using a GIS database you could develop your own questions regarding proximity of rivers to major towns and cities in South Africa or ask the learners to locate the closest streams and major rivers to their own locations (school). You can combine this activity with reading rainfall maps in the atlases so that you can ask the learners questions that will "scaffold" learning. That is, learners first understand where rivers and dams are located, their sizes and other information from reading sources, then expand on this knowledge by interpreting rainfall maps and understanding that rainfall is unevenly distributed across the country. (See the Grade 12 CAPS requirement that learners develop a "paper GIS" from existing maps, photographs or other records.)

ACTIVITY 2

WATER SECURITY

See page 13 in the *Methods and Processes* booklet.

Method used: Information transfer methods – Demonstrations and experiments

Doing a demonstration or conducting experiments that are visual, allow learners to view causes and effects of certain processes that can be difficult to explain using words. Modeling a situation, especially if learners have to research and make a model on their own, can help with understanding how a process works systematically and as a whole. There is a chance, however, that a learner may not make the connection between the model

and the real world; this link can be reinforced with the use of case-studies, fieldwork and action research. This activity uses a mini-ecosystem, built in a large jar, as a model for the processes that take place within our biosphere. These processes take place on a smaller scale, and can be observed. Through pointing out and discussion of these processes the model can be used to demonstrate what happens on Earth on a larger scale.

Links to CAPS

This activity helps to develop the following knowledge and skills as described in CAPS

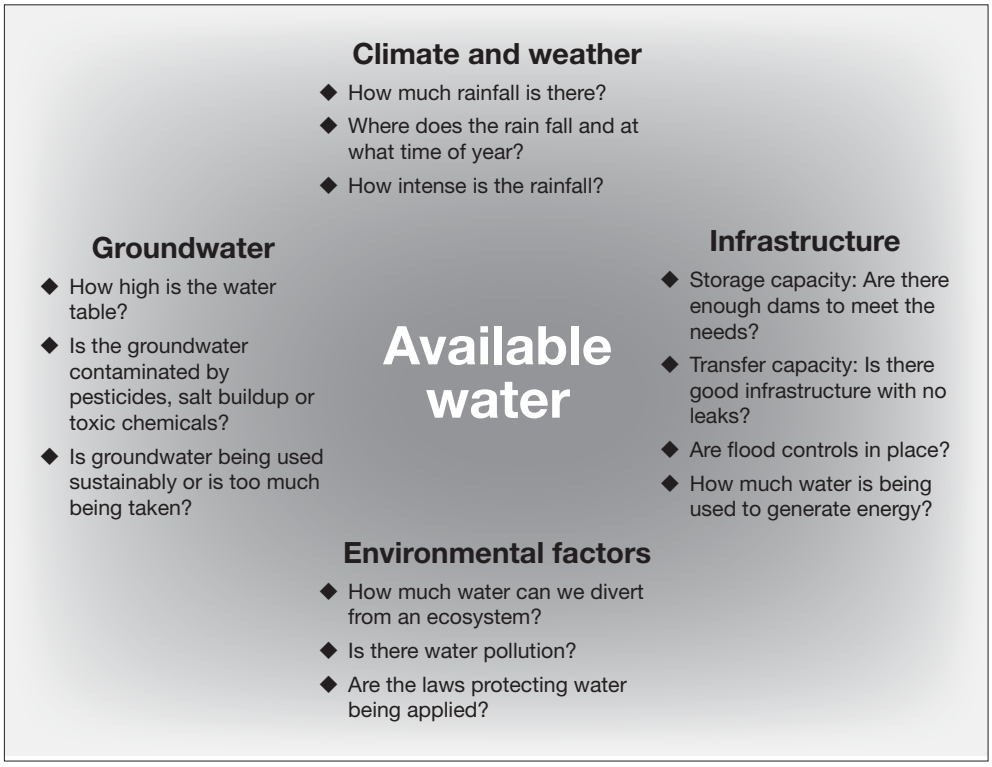
- Identifying questions and issues;
- Collecting and structuring information;
- Making decisions and judgments;
- Deciding on a point of view;
- Suggesting solutions to problems; and
- Working co-operatively and independently.

Core knowledge

Water resources in the world and in South Africa

There is a finite amount of water within our atmosphere and on land, but it is not evenly distributed. Certain atmospheric and geographical processes affect how water is distributed across the globe. Within a country, various socio-economic and political factors can also affect their water security. South Africa is a water scarce country and has to manage water resources wisely. The quality of our water is a critical element to achieving sustainability. Forty percent of the world has no access to clean water and sanitation, while in the developed world we have been using our water reserves at a much faster pace than they can be regenerated. A worldwide water shortage is projected with the current pace of demand outstripping supply in many regions within our lifetimes (Ball, 2009).

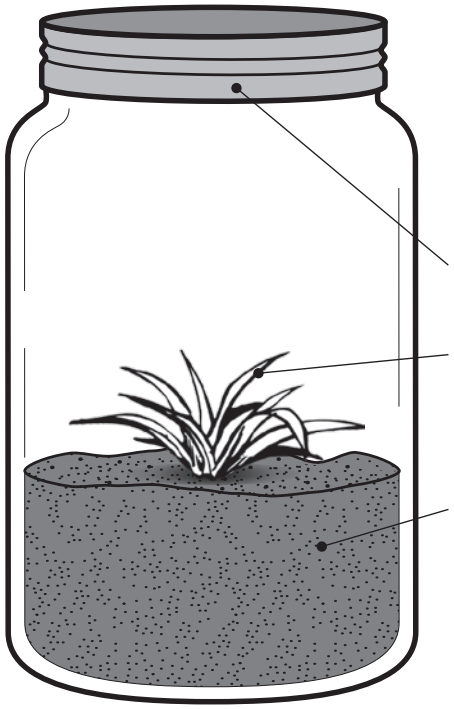
Water available for use is affected by the following factors:



Outline of activity

The aim of this activity is to view and understand the water cycle, engage with the fact that it is a closed system and lead into exploring the causes of water insecurity.

1. Build your own mini-ecosystem using the diagram below and present it to your class.



BUILD A MINI-ECOSYSTEM (in a jar or bottle)

Plant a small plant in a large glass jar and seal it, write down the date it was planted, watch and record what happens in the jar.

Tightly sealed jar – you can use silicone sealant to ensure that it's sealed properly.

Plant a small plant – preferably a weed from your garden.

Soil – fill 1/3 of your jar with a mix of moist soil from your garden and potting soil. If the soil is very dry add a little bit of water, but don't add too much!

If you don't have a big glass jar, you can use an empty 2L plastic bottle. Cut off the top, plant your plant, and then put the top back on and seal it using clear sticky-tape and silicone sealant. Make sure there are NO GAPS for the air to escape, otherwise your plant will dry out and die.

2. Ask learners to write down the first four questions that come to mind when they examine the mini-ecosystem. Allow them to discuss their questions in groups. Predictably, most of the questions will be something like:

   "How does the plant get air?"

   "How does it get enough water?"

   "How big will the plant grow?"

   Most of these can be answered with discussion about how the mini-ecosystem is a **closed system**. Every process that occurs on our planet to sustain life, happens in the mini-ecosystem on a smaller scale. Lead the discussion into how the water cycle is a closed system, review each step and ask the class to point out which parts of it they can observe happening inside the bottle/jar.

3. Reflect on what the learners discussed previously, and put forward the questions:

   - If the water cycle on planet Earth is a closed system and there is a **finite** amount of water found within that system, why do we have areas that suffer from water scarcity and other areas where water is abundant?
   - What factors affect the distribution of water across the globe?

4. Ask learners to observe their mini-ecosystems and discuss the questions:
   - If the bottle or jar is left in exactly the same place every day, is **liquid** water equally distributed throughout it? Why is this?
   - Which biophysical features and atmospheric processes would affect rainfall patterns and infer similarities with features in their mini-ecosystems. Compile this as a table of comparisons.
   - What would happen within the jar/bottle if, hypothetically, some of the liquid water became polluted? How would this affect the plant inside? Illustrate the **dynamic equilibrium** inside the bottle, and how it would be disrupted. If this was inferred to a global situation what issues would it bring forward?
5. Discuss the questions above in groups, and then with the class.
6. Read the extract below and then answer these questions:
   - Why are some countries listed as 'water-scarce' or 'water-stressed' and others not?
   - What **other** factors affect water security within a country, and in particular South Africa?

   ***"South Africa** is recognised as a water-scarce country in terms of a commonly used definition, namely that of the average "total actual renewable water resources" (TARWR) per person per year. Using this definition, South Africa is the 29th driest country out of 193 countries, with an estimated 1110 cubic metres (m^3) of water per person in 2005. Most of the "drier" countries are either small islands or oil states in the Middle-East (UNESCO-WWAP, 2006). The use of TARWR per person was proposed in an attempt to determine a country's water requirements for food self-sufficiency. According to Falkenmark (1986), a country faces water stress when per capita water resources fall below 1667 m^3 per capita, water scarcity when there are less than 1000 m^3 per capita, and absolute water scarcity when water resources are below 500 m^3 per capita. Other useful indicators of water stress are the intensity of use, the proportion of TARWR actually used, and thus the extent to which water availability is a current constraint.*

   South Africa, which uses 31% of its TARWR, is again a relatively extreme case. Only 31 out of 163 countries surveyed use water more intensively. These are mainly oil-rich or island states that rely on water from non-renewable sources, such as fossil groundwater or desalinated seawater. Countries such as India, Pakistan and Spain, however, which have extensive irrigated agriculture, use a greater proportion of their water than South Africa does. Water is frequently pumped from underground sources at a rate faster than can be replenished. Although both indicators provide some perspective on a country's natural resource endowments, they should be interpreted with care. Their implications depend heavily on the nature of the geography and the economy of the country concerned. Thus, "arid" Botswana has a TARWR of 6820 m^3 per capita, which is more than six times that of South Africa. However, the water is located in the northwest, while the population is in the southeast, and almost all the water is reserved to sustain the Okavango Delta wetlands.

   Another example of the limits to using TARWR is provided by the small island state of Singapore, which has a TARWR of only 139 m^3 per capita. Although apparently drastically constrained by limited water resources, the country's economy has boomed since it became independent of neighbouring Malaysia in 1965. When water imports from Malaysia came under threat due to diplomatic differences, Singapore embarked on a programme to achieve water security. This

was done through a mixture of conservation, rainwater harvesting, desalination of seawater and the reuse of wastewater. In the process, Singapore's public utilities board and its associated industries gained so much water management expertise that they are now highly sought-after as management and technological consultants throughout the region."

(Source: Muller, M. et al. 2009. Water security in South Africa. Development Planning Division. Working Paper Series No.12, p.8. DBSA: Midrand. Available from http://www.dbsa.org/Research/)

Assessment

As an assignment for the learners to complete at home, get them to make their own mini-ecosystems (observe what happens when it isn't sealed properly and air with water vapour escapes).

The activity involves the following: observing and understanding processes; writing up research; writing paragraphs and essays; evaluating arguments and expressing and supporting a point of view. These processes can be used as part of the informal/daily assessment or as a formal essay writing task.

Developing your Teaching Practice

Work together in pairs to identify the **methods** used in the above activity. The main method outlined above, used the mini-ecosystem to **demonstrate** the systems and processes surrounding the hydrological cycle and how that affects the distribution of water across the globe. What additional methods were used to complement this? Can you think of other methods that could have been used? Discuss this and report back to the group how you could have strengthened the learning in this situation.

ACTIVITY 3

FACTORS AFFECTING WATER QUALITY

This activity aims to provide learners with reading material that will help them to contextualise and understand the sources of water contamination and the impacts of poor water quality on communities. Through this process learners will think deeply about the values they hold and about access to clean and safe drinking water as a basic human right. They will also gain some insight into the costs and challenges to municipalities as they struggle to provide water to communities in some areas.

See page 32 in the *Methods and Processes* booklet.

Method used: Deliberative methods - Media analysis

Reading to Learn and Values Clarification: Understanding complex issues using media articles

Newspaper articles can be a very valuable resource to contextualise issues that are affecting communities in South Africa and to enhance literacy and critical thinking skills. One has to be careful when choosing media articles, as these can be biased and may contain errors. As a "knowledgeable teacher" you are encouraged to seek sources of information from different sources and to then evaluate which ones would be appropriate for your learners. A selection of media articles from various sources that contextualise the issue of water quality and health impacts on the community of Delmas, Mpumalanga are provided for this activity below.

Links to CAPS

This activity helps to develop the following knowledge, skills, attitudes and values as described in CAPS:

- processing, interpreting and evaluating data;
- challenges to providing free basic water to rural and urban communities in South Africa;
- the role of government initiatives towards securing water;
- factors influencing the availability of water in South Africa;
- respect for the rights of all people;
- a concern for the sustainable and fair use of resources for the benefit of all; and
- making decisions and judgements.

Core knowledge

Water quality challenges

There are many sources of water pollution that impact upon water quality in South Africa. Water quality can refer to the quality of water in rivers and oceans as well as water quality in terms of drinking water quality from municipal water treatment facilities. There are different standards for water quality in South Africa (for example the WESSA Blue Flag programme which monitors coastal and estuarine water quality and the Blue and Green Drop reports that monitor drinking water quality).

The main contributors to water quality problems are mining (acidity and increasing metals content), urban development (salinity, nutrients and microbiological), industries (chemicals and toxins) and agriculture (sediment, nutrients, agro-chemicals and salinity through irrigation return flows) as well as, in many areas, untreated or poorly treated wastewater (NWRS, DWA, 2013).

It is important to consider with learners sources of water pollution, impacts on communities, as well as the challenges of providing free basic water to rural and urban communities.

Assessment

Working with a variety of data; and writing up research; writing paragraphs and essays; evaluating arguments and expressing and supporting a point of view.

How is this activity experiential learning?

This activity requires learners to "experience" the problems facing the community of Delmas through text, by reading and discussing with each other the issues facing the community, the sources of the problem and the possible solutions. Through the process of "framing" the issue, the learners will go through a process of clarifying their own values. They should experience the issue through contextualisation and relating this issue to their own experiences of water quality.

Outline of activity

Newspaper articles covering water issues in Delmas from 2007 to 2013 are given below.

Media Articles on the Delmas Water Issues

Minister drinks water to prove Delmas point
November 21 2007 at 12:50am

The cause of the outbreak of diarrhoea in Delmas was not tainted water, Water Affairs Minister Lindiwe Hendricks said on Tuesday. “Delmas tap water is safe for human consumption,” said the minister, drinking a glass of water. “The results from tests conducted on water samples taken from Delmas have proved negative for micro-biological contamination,” she said. “Indicator organisms were tested for prescribed South African national Standards and the result proved negative for the presence of any diarrhoea-causing contamination.”

Hendricks said the analysis was performed at five different laboratories. The department’s Drinking Water Quality Regulation Unit joined forces with the University of Johannesburg in conducting the Delmas investigations following the outbreak last month. “A number of analytical tests were conducted to determine whether the water that is currently been reticulated is safe, as well as to establish whether a link exists between the increasing cases of diarrhoea and the drinking water,” the minister said. “During the investigations it was established that the resource water in one of the three boreholes during September proved to be contaminated and could have been a trigger for the initial increase in the number of cases of diarrhoea.”

Chlorination was required to deactivate contaminants before water was reticulated and consumed. This had been immediately done and the process was continued with support from the department of water affairs and forestry. In addition to these measures, the department was urging the Delmas community to continue to boil their water before use. The number of affected people has risen to 1006 since the out-break in October. The results on samples of food taken for tests will be announced on Wednesday. Hendricks said her visit to Delmas was out of concern following the increase in the number of people affected by diarrhoea. Her department would continue to help the Delmas municipality improve the water quality and ensure their water was safe to drink.

As a supporting measure, a reservoir would be built in Delmas at a cost of R1.5 million by the department. The minister also announced her department would pay R120 000 for the cost of tests conducted by the University of Johannesburg. Six officials had been deployed to Delmas as well as experts from the Institute of Water Quality. Though the minister urged the community to boil water as precautionary matter, residents told reporters they had lost trust in boiling water. Maria Sisphuma, a mother of five children from Botleng township near Delmas, said she now bought water from local shops because she did not want her children to get sick. “When you boil the water and put it inside a fridge the colour changes to a brownish colour as if it has been mixed with vinegar. After drinking your tongue become dry and heavy,” she said. She now buys water daily at a cost of R8.50 per five litres. A technician from the water quality unit of the department of water affairs, Leonardo Manus, said the colour of the water changed due to the presence of magnesium in the water, which he said was not harmful.

Mpumalanga premier Thabang Makwetla said the results from tests conducted on milk and vegetables would be released on Wednesday. “The preliminary results are available, but we will only release the final result tomorrow (Wednesday) because more details need to be finalised,” the premier said. Makwetla called on the Delmas municipality to take proper actions if human error was found to be the cause of fluctuation of chlorine in the water during September, which was suspected to have triggered the outbreak. “Chlorine levels were not constant. At some stage they were

above the required level and some times below. We suspect water might have been contaminated at that point," he said.

– Sapa

Delmas finally gets clean purified potable water – extract
Friday 2 December 2011 19:07

The people of Delmas in Mpumalanga will for the first time since 1993 have clean purified potable water. The provincial government has handed over an R80 million water treatment plant to the community. The plant is expected to ensure that all the water from the boreholes is purified before it is consumed.

In 1993, a diarrhoea outbreak left more than 20 people dead, and in 2005 a similar outbreak left five dead and scores hospitalised. Gogo Nomgqibelo Mahlangu has been a resident in extension-three Delmas for over 20 years. She has seen it all – a diarrhoea outbreak every four years and service delivery protests. They had to cook and wash with contaminated water as well as drink it. This left them sick and their washing not so clean. Mhlangu says water has always been dirty, sometimes turning brown. They would be sick and suffer diarrhoeal diseases, but for the past few weeks things have changed and there have been no water cuts.

Executive Mayor Eva Makhabane says some of the boreholes got contaminated and that led to viruses inside the system hence people got sick. Most water in Delmas is drawn from boreholes. But it is often contaminated due to weak sanitation and ageing infrastructure.

The plant is expected to ensure that all the water from the boreholes is purified before it is consumed. It will also pump up to 15 megalitres of water daily. Consulting Engineer Pieter Joubert says the plant has been designed to kill all germs through the ozonation process. Water has always been a health hazard in Delmas and residents have staged numerous protests. But with the new water treatment plant, both the residents and authorities believe water problems are over.

– SABC

Delmas at risk as sewage contaminates water
Published on Thursday, 02 August 2012 11:21

Residents of Delmas in the Victor Khanye local municipality's health has been compromised by raw sewage spilling into the Blespokspruit, and the DA is highly concerned that we may see yet another typhoid outbreak. Of the three sewage treatment plants in the area, two are overloaded and in desperate need of an overhaul. However, these cannot be shut down as the new Botleng plant (which cost R40 million and was handed over in November 2011) has not been operational since February, when the lack of maintenance caused the blowers to stop working. The motors have since been taken in for repairs, but it is not clear when they will be repaired or when the plant will be operational again. The resulting effluent discharges into the Blesbokspruit poses an immediate danger to the approximately 30 000 residents of Botleng, who are at risk of contracting waterborne diseases such as typhoid and cholera, and government needs to act immediately. This community, and others downstream, certainly do not need another typhoid outbreak such as that of 2005, when a borehole contaminated with human waste hosted salmonella typhii, the bacterium that causes typhoid. The DA will write to cooperative governance MEC Madala Masuku and ask him to send a joint departmental task team, not just to Delmas, but to every municipality and establish the extent of the water contamination, as its widely known that almost every municipality in Mpumalanga discharges

sewage into water systems. We will also ask MEC Masuku to make contingency funds available and get all three sewage plants operational as soon as possible. The health and well-being of Mpumalanga's communities cannot be compromised.

James Masango MPL, Spokesperson for Cooperative Governance

Minister of Water launches multi million rand water pipeline in Delmas
To All Media
16 July 2013

The Minister of Water and Environmental Affairs Mrs. Edna Molewa, MP, together with the Premier of Mpumalanga Mr. David Mabuza has today,Tuesday, 16 July 2013 launched the Bloemendal bulk water project in Delmas.

This project, valued at R171 500 000, is in the Victor Khanye Local Municipality, one of six local municipalities within the Nkangala District of Mpumalanga Province The bulk water project is part of the government's drive to bring services to the people of the country. The Minister said that Delmas was particularly critical as it has in the past experienced serious water challenges some of which resulted in the break-out of waterborne diseases. "The launch of this bulk water project will go a long way in addressing water shortages in the area and ensuring that there is no repeat of what happened in the past" she said.

The available volume of water over time has been inadequate to guarantee a constant supply for Delmas especially in the dry seasons. The construction of the Bloemendal-Delmas Bulk Water Project will now address the water shortages for Delmas while allowing for future growth and development. The project is designed to supply 25 megalitres a day and will be sufficient to meet water demand in the service area up to the year 2026. The new project incorporates a 10 megalitre reservoir located at mid-point of the new pipeline and is also designed to improve system operation. With the introduction of the Bloemendal – Delmas Bulk Water Project, the water distribution network is being reconfigured such that the Rand Water connection at Modder-Oos Reservoir supplies water to the reservoirs at Sundra and Eloff.

The Modder-Oos Reservoir amounts to 1.825 mil m^3/a. This area has 1 367 households. The yield from the boreholes which can provide up to 3.5 mil m^3/a is retained to supply Botleng extension 3, 4, 5,6 and the extension 7 which is yet to be developed. This scheme will serve 7 640 households, a further 1 406 households will be added into this system as part of the planned Extension 7 of Botleng.

The project will have further impact on the other areas within the Municipality as well. The Bloemendal –Delmas Bulk Water Project will service Delmas (town), Delmas West, Delmas Extension 1-7, Scheme 88, Delpark, Delpark Extension 2 & 4, Botleng Proper and Mandela informal settlement. The total number of households in this service area is 6 880. More importantly, the Water Distribution network is designed such that all the water distribution zones are interconnected.

The Minister and Premier are still concerned that communities in the outlying Municipal areas like Hawerklip situated approximately 21 km South East from Delmas and Groenfontein situated 34km North East from Delmas, are currently receiving water by means of water tankers. They made a commitment that boreholes will be drilled for these communities in order to have a non-interrupted water supply.

They are also concerned about those communities living on privately owned land which do not have access to basic services. The responsibility to provide potable water to these communities between the municipality and the landowner is a matter that needs urgent attention. Currently, these small communities are serviced by means of water tankers from the Municipality.

The Municipality has serious challenges around the matter of water conservation and demand management. These challenges are primarily as a result of household leakages and high pressure exerted on the supply pipeline during times of high demand.

To ensure the water supply during these high demand periods, the VKLM rations the water supply between 05h00 and 11h00 as well as 16h00 and 21h00 so as to reduce the water loss and elevate the water levels in the reservoirs to levels that will ensure water supply at Botleng Extensions 4, 5 and 6 which are high lying areas at almost the same elevation as the reservoir.

1. Read the newspaper extracts, underlining the key ideas and points in the text.
2. In pairs or groups, construct a timeline of the issues and solutions that are provided to the community of Delmas.
3. Using your atlas, locate the area on a map. Identify the catchment. Identify the key industrial activities in the area.
4. Discuss the following:
   - What caused the problems and what solutions were provided?
   - Consider the sources of water for the community (e.g. groundwater) and how these sources have become contaminated.
   - Discuss the impacts pollution has had on the community.
   - Identify the reasons for the shortages of water and what solutions have been proposed over the years.
   - Explain why some of these solutions have not been effective.
   - Consider the cost of the solutions. Are there any other possible solutions?
   - What is the role of government in providing access to safe drinking water and what are some of the challenges of providing this?
5. Learners can report back verbally in a general class discussion. From this discussion, learners can submit their own individual reports on the issue, highlighting their own perspectives or "frames" regarding water as a basic human right.

Developing your Teaching Practice

Contextualising water issues is a very valuable learning methodology. While learners may be able to read and understand the factors affecting water quality in South Africa and may be able to read about the challenges of providing this, learning may be enhanced if they are able to learn about a context that is familiar to them. Considering where you live and the school that you teach at, are there any examples of challenges to water quality that you are aware of? Are there any other ways to explore ideas of rights to water and to help learners to "frame" their views on the issue and to clarify their values? What are your views on water quality issues and the challenges of providing safe drinking water to rural and urban communities?

Assessment Practice

Formal assessment requirements in the Further Education and Training Phase Grade 10-12 Geography are summarised in the table below.

Summary of Formal Assessment (from CAPS p.50) for Grades 10-12:

GRADES	FORMAL SCHOOL-BASED ASSESSMENTS	CASS 25%	FINAL EXAMS (75%)	TOTAL
10 and 11	3 assessment tasks 2 tests Mid-year examination	3 x 20 = 60 2 x 10 = 20 1 x 20 = 20 **100**		
	End of year exams		Paper 1 = 225 Paper 2 = 75 **300**	**400**
12	3 assessment tasks 2 tests Mid-year examination Trial exams	3 x 20 = 60 2 x 10 = 20 1 x 10 = 10 1 x 10 = 10 **100**		
	End of year exams		Paper 1 = 225 Paper 2 = 75 **300**	**400**

In addition, a range of cognitive levels need to be designed into formal assessment tasks as shown in the following table.

	COGNITIVE LEVELS AND CORRESPONDING WEIGHTING FOR EACH GRADE		
	Knowing and remembering	**Understanding and applying**	**Evaluating, analysing and creating**
Grade 10	40%	40%	20%
Grade 11	30%	50%	20%
Grade 12	25%	50%	25%
Examples of useful verbs for the different cognitive levels			
	State Name Label List Define Describe	Explain Compare Rearrange Give an example of Illustrate Calculate Make a generalisation Predict Apply Use knowledge Demonstrate Solve Implement Judge	Select Differentiate Analyse Infer Suggest a reason Discuss Categorise

Assessment tasks

The CAPS suggests that three assessment tasks should be used for **formal** assessment and the suggested guideline is one per term in Terms 1 to 3. Pages 51-54 of the CAPS documents suggest that in each year, a data handling, mapwork and research/essay writing task be completed for formal assessment.

Assessment in Geography should be guided by:

1) Knowing and understanding geographically;
2) Working with data (from a variety of sources); and
3) Making judgements and decisions.

These ideas are explained in more detail in the CAPS Geography Grade 10-12, p.59.

Tasks for the teacher

1. Exploring cognitive levels

a) Use the verbs listed for the different cognitive levels to set a test out of 20 marks on the content covered in Activity 1 at Grade 10 level. Use the correct cognitive demand weighting for Grade 10. Use the table below to assist you.

Linking the Activity Content Knowledge to Assessment Processes

Activity	Content Knowledge Section	Section Summary	Assessment Activity Examples from the Methods Section	Key assessment skills (verbs)
1	Definition of key geographical concepts – water availability and accessibility – location, place, region, space, distribution, pattern, scale, physical processes, characteristics	Water cycle, drainage basin, catchment, precipitation, surface flow, groundwater, water pollution, microbiological pollution, estuaries, wetlands, inter-basin transfers, storage dams, environmental impact assessments, water use inefficiencies, climate change	Rivers, dams and drainage basins in South Africa – mapwork activity using atlases and GIS. Mapwork and data handling task	Define, describe, list, name, observe, recall, illustrate, measure, record (draw) Identify, name, organise, categorise, list, classify, select, differentiate

b) Include a memo for the test you set.

2. Identifiying skills, attitudes and values

a) Pages 9 and 10 of the FET Geography CAPS includes a list of geographical skills, attitudes and values and key questions for different methods of inquiry. Identify which skills, attitudes, values and method of enquiry were being developed in Activity 3.

b) Discuss how you could incorporate mapwork skills into Activity 3. Make a list of resources that would be required.

Unit 2

Water and development

This Fundisa for Change unit focuses on water access and development as we move into the future.

The key questions addressed by this unit are:

- How does water availability affect population distribution and development?
- What effects might water have on future development in South Africa?
- What factors impact on water security?
- How might climate change impact on water security in South Africa?

Relevant CAPS topics are listed in the table below.

KEY CONCEPTS AND PROCESSES	GRADE	TERM
THE ATMOSPHERE ***Heating of the atmosphere*** ◆ Greenhouse Effect – impact on people and the environment; ◆ global warming: evidence, causes and consequences, with reference to Africa; ◆ impact of climate and climate change on Africa's environment and people – deserts, droughts, floods and rising sea levels.	10	1
POPULATION ***Population distribution and density*** ◆ meaning of population distribution and population density; ◆ world population density and distribution; and ◆ factors that affect distribution and density of the world's population.	10	3
WATER RESOURCES ***Water management in South Africa*** ◆ rivers, lakes and dams in South Africa; ◆ factors influencing the availability of water in South Africa; ◆ challenges of providing free basic water to rural and urban communities in South Africa; ◆ the role of government – initiatives towards securing water: inter-basin transfers and building dams; ◆ role of municipalities: provision and water purification; and ◆ strategies towards sustainable use of water – role of government and individuals.	10	4
THE ATMOSPHERE ***Africa's weather and climate*** ◆ Africa's climate regions; ◆ reading and interpreting synoptic weather maps. ***Droughts and desertification*** ◆ areas at risk: regional and local scales; ◆ effects of droughts and desertification on people and the environment, such as differences in vulnerability.	11	1
DEVELOPMENT GEOGRAPHY ***Frameworks for development*** [6 hours] ◆ factors that affect development, including: access to resources, energy, history, trade imbalances, population growth, education and training, natural resource limitations and environmental degradation (note: learners need to explore the complexity and interrelated nature of these factors); ◆ development models: free market models, such as Rostow's model with its limitations and criticisms, core and periphery models with their application at different scales; sustainability models with their economic, social, and environmental elements; and ◆ community based development, including approaches to rural and urban development.	11	3

Development issues and challenges [4 hours] ◆ the role of women in development: gender issues related to power, access to resources and attitudes; ◆ the effect of development on the environment; ◆ the role of the state and business in development in South Africa, including central control by the state, weak state control and public private partnerships.	11	3
RESOURCES AND SUSTAINABILITY ***Using resources*** [3 hours] ◆ the relationship between resources and economic development; ◆ exploitation and depletion of resources; and ◆ concepts of sustainability and sustainable use of resources. ***Energy Management in South Africa*** ◆ South Africa's changing energy needs; ◆ energy management, towards greener economies and sustainable life styles: responsibilities of governments, businesses and individuals.	11	4
ECONOMIC GEOGRAPHY OF SOUTH AFRICA ***Agriculture*** ◆ factors that favour and hinder agriculture in South Africa, such as climate, soil, land ownership and trade; ◆ the importance of food security in South Africa – influencing factors; and ◆ case studies related to food security in South Africa.	12	3

Subject Content Knowledge

Introduction

This unit deals with factors that affect water availability in terms of access to water and the critical factors such as catchment management, integrated water resources management while adopting a nexus thinking approach to managing water resources.

Water planning and policies affecting water use and availability need to be carefully planned. This cannot be planned, however, in isolation as decisions taken in planning and policy in other sectors can have a very big impact on water availability and water access.

Water access remains a key development and human rights issue in South Africa. Despite the fact that more than 90% of the population has domestic water supply, there are issues with respect to equity and distribution of water: a lack of water availability and water infrastructure in rural areas is an impediment to water based rural livelihoods and food security, particularly for sustainable small scale agriculture in rural areas. Water and development are also linked to population growth and water, energy and food security.

Summary of subject content knowledge

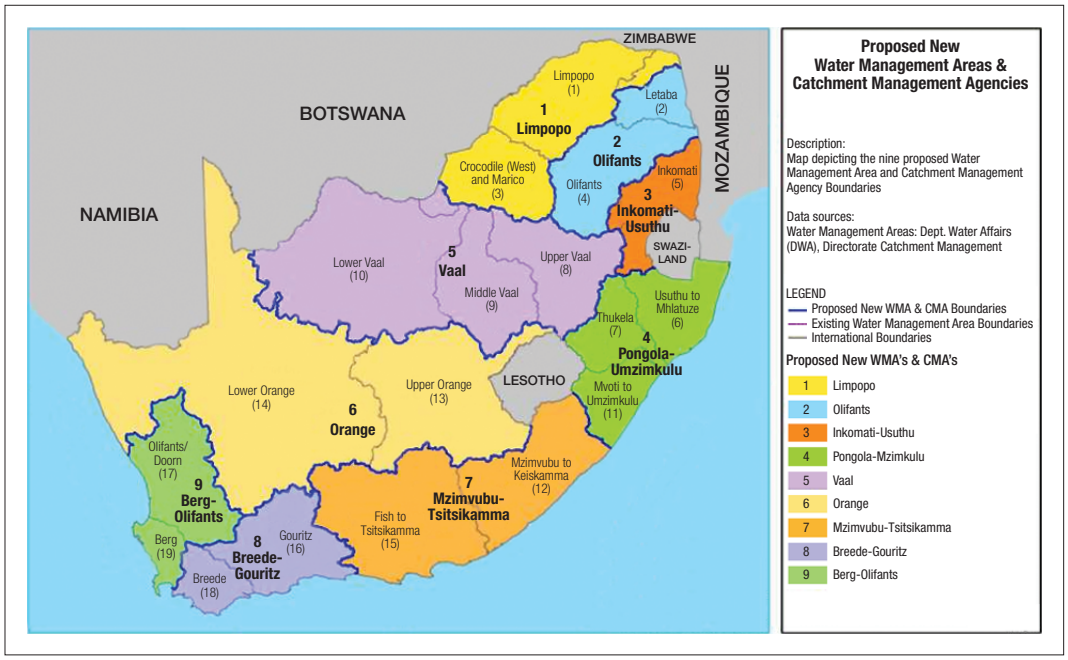
Water policies

The National Water Act (Act 36 of 1998) calls for the development of strategies to facilitate the proper management of water resources in South Africa. The National Water Act is the legal policy which guides water use and water planning in South Africa, and the National Water Resource Strategy (amended NWRS2, 2013) is the legally binding policy document for implementation of the National Water Act (1998). It provides a framework for the protection, use, development, conservation, management and control of water resources for the country as a whole. The National Water Act stipulates that the NWRS must be reviewed every five years. The strategy document legally binds national, provincial and municipal water management authorities (including catchment management agencies, water service authorities, water boards and other users of water) and provides guidelines and suggestions for the proper management of water resources in South Africa.

The NWRS2 describes the water sector vision as aligned with the Vision of South Africa 2030 (National Development Plan) which is: “Sustainable, Equitable and Secure Water for a Better Life and Environment for All” (DWA, 2013). The NDP further lists the goals of Vision 2030 as “eradicating poverty and sharply reducing inequality” and as water contributes to the economy and job creation, the achievement of these goals will require careful planning and management of water resources. As such it is important to consider this section on water management in terms of the strong link between water management and development.

Catchment Management Areas – Water Management Areas

South Africa had 19 catchment management areas in 2013. However these have now been re-defined into nine new catchment management areas. Water management in each area entails the development, financing, managing, operating and maintaining of bulk water services (water and wastewater). These are to be fully established and operational by 2015.



Source: DWAF – http://www.dwaf.gov.za/nwrs/LinkClick.aspx?fileticket=xQF4Z90aFvM%3D&tabid=72&mid=435

In addition to the Catchment Management Agencies, there are also Catchment Management Forums which form the non-statutory bodies that represent stakeholders who are able to participate and inform the decision-making that is under the authority of the catchment management agencies.

Approaches to catchment management

Integrated catchment management or **Integrated Water Resources Management (IWRM)** is an approach whereby water resources and other resources which may be interdependent on the water resource are used and managed in order to ensure sustainability of both water quality and water quantity. This entails planning in an integrated way for water use and the protection of water resources together with planning processes that are underway in the mining, energy, tourism, agricultural, and other sectors. All sources of water (rivers, lakes, groundwater, wetlands etc.) are managed as part of an integrated cycle. The river basin catchment area is taken as the basic unit and communities and their needs are the focal point.

The approach needs to be balanced in order for attention to be given to economic development and protection of resources while meeting basic human, social needs and expectations such as access to safe drinking water and sanitation. A key challenge to integrated catchment and water management is that it requires inter-departmental cooperation. For example, the management of sanitation falls under the legislative control of the Human Settlements Department, yet issues of eutrophication and microbiological pollution linked to inadequate treatment of wastewater from sewage treatment plants directly impact on the goals of Department of Water Affairs and Forestry. Catchment Management Forums and Water User Associations also have a critical role to play in integrated catchment management.

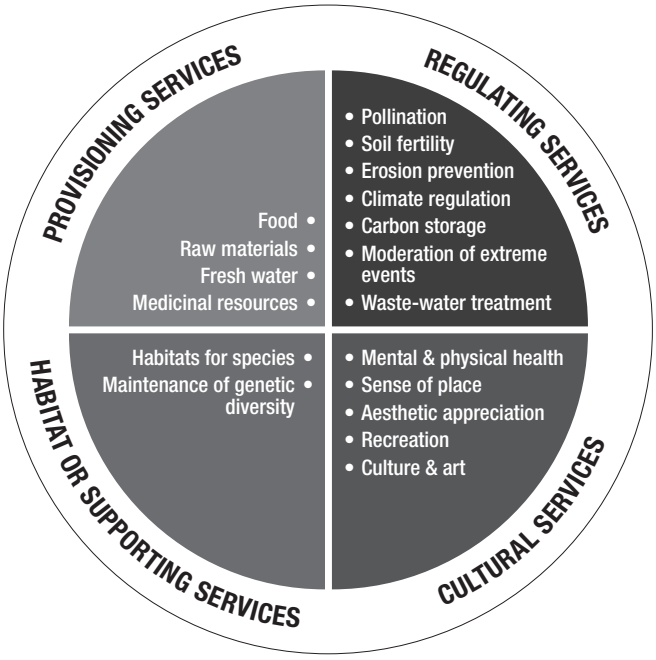
The National Development Plan "Vision 2030" outlines a new development path for South Africa which seeks to eliminate poverty and reduce inequality by 2030. The focus is on job creation (11 million jobs by 2030) by development of the mining and industrial sectors including the issuing of fracking licences in the Karoo. All these activities are potentially detrimental to water resources.

Water resources protection

Strategies for water resources protection outlined in the NWRS2 (2013), include:

1. Setting resource quality objectives for "significant" water resources to ensure regular water monitoring for compliance and the maintanence of water ecosystems in a "desired" state
2. Investment in strategic water sources including raising the price of water in these areas and re-investing funds thereof into the continued management of the water source
3. Maintanence and rehabilitation of key water ecosystems
4. National Freshwater Priority Areas (NFEPAs)
5. Protection of riparian and wetland buffers – recognised as critical ecological infrastructure for groundwater recharge, supporting water security and as a buffer against drought
6. Monitoring of WMAs through programmes such as the River Health Programme, Wetland Health programme and the estuary health programme
7. Minimising of pollution from wastewater treatment works through wastewater recycling systems, wastewater risk abatement plans and Green Drop certification, etc.

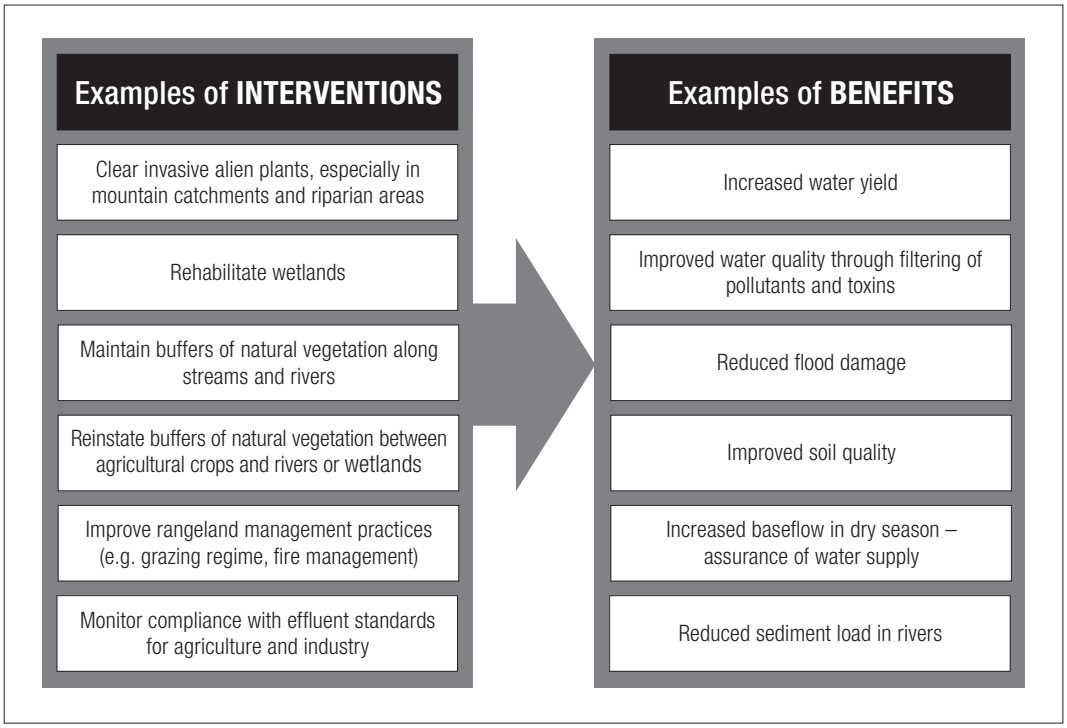
Conserving, rehabilitating and maintaining ecosystem services



Ecosystems provide a number of "free services" to society upon which we all depend. Some of these services are listed in the diagram on the left.

In terms of Water Resources Protection, aquatic ecosystems, including wetlands and estuaries, provide valuable services in terms of water security in South Africa. The protection and restoration of the integrity of damaged ecosystems such as wetlands helps to reduce the costs of maintenance of other dam and water supply infrastructure that would be affected by sedimentation. This further helps to reduce the risks of floods that would also negatively impact other infrastructure such as roads and bridges.

An efficient way to invest in water security is to protect water at its source through good land management. In this way investing in land management becomes a water quality and water quantity investment. The diagram below shows examples of interventions to protect ecological infrastructure and the associated benefits.



Source: Adapted from SANBI Grasslands Fact Sheet: Ecological Infrastructure: Nature Delivering Services, August 2013

Wetlands

Wetlands are regarded as one of South Africa's most important and threatened ecosystems. Wetlands have also been identified as critically important for groundwater aquifer recharge as it has been recognised that in South Africa, "surface water availability and its remaining development potential will not be sufficient to support the growing economy and associated needs in full and that the limits to the development of surface water resources almost been reached and that the opportunities for the economic siting of new dams are few" (NWRS2, 2013).

Wetlands purify, store and regulate the flow of water and provide habitat for many species and are stated in the NWRS2 as being important for both ensuring water quality and water quantity. Alarmingly, in South Africa over 50% of all wetlands have been converted to other land use purposes! They have been drained for agricultural purposes, eroded, filled in for construction, covered by dams, polluted by industries and used as dumping grounds. Wisely using our wetlands is an essential component of sustainable water management. The onset of the more extreme weather conditions we can expect with climate change means that wetlands will become even more critical for water management, slowing water down during storms and storing it during seasons of drought.

Water Conservation and Water Demand Management (WCWDM)

The Department of Water Affairs and the Water Research Commission (WRC) have been working together to develop guidelines for municipalities to assist in WCWDM.

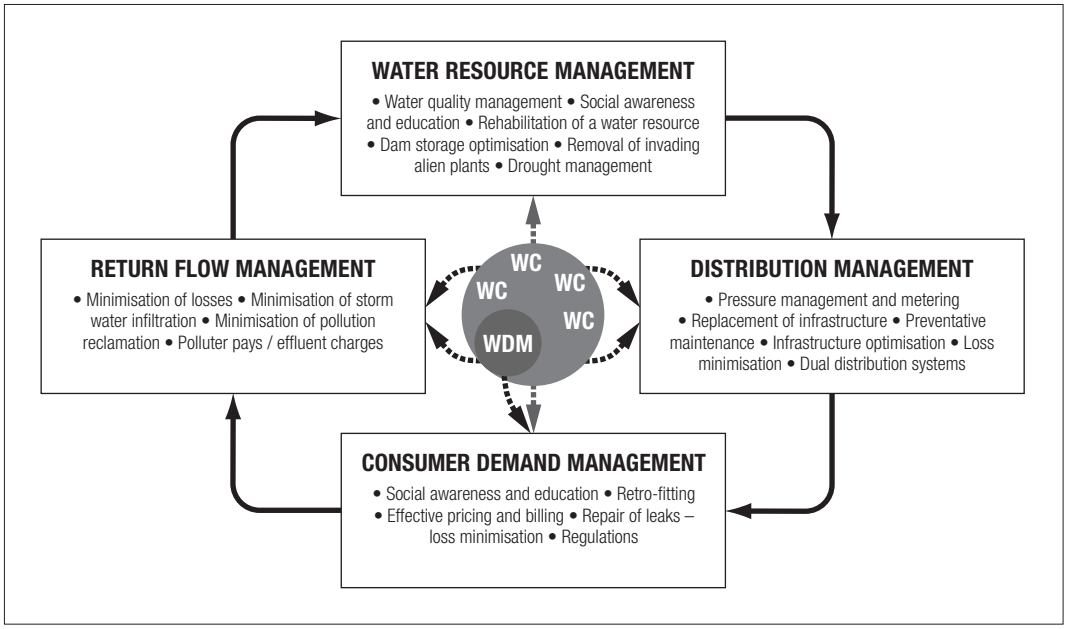
Water conservation is defined by the NWRS2 (2013) as the minimisation of loss or waste, the care and protection of water resources and the efficient and effective use of water. The WRC estimates that 25% of water is lost through leaks and other inefficiencies.

Reducing water loss inefficiencies and adopting water conservation strategies in municipalities would substantially increase water availability. This could include water pricing increases to encourage efficiency in water use and conservation.

Coca Cola was awarded the Eco-Logic Awards for 2013 for the water efficiency technologies that they implemented at their bottling plants.

Water Demand Side Management is the adaptation and implementation of a strategy or a programme by a water institution or consumer to influence the water demand and usage of water in order to meet any of the following objectives: economic efficiency; social development; social equity; environmental protection; sustainability of water supply; and services and political acceptability.

Elements of WCWDM



Source: Adapted from C. J. Seago and R. S. McKenzie, 2007 in NWRS2, 2013

Transboundary water management

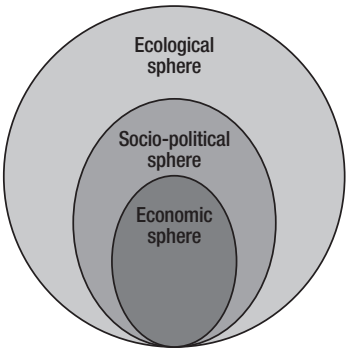
Approximately 60% of the streamflow in South African rivers is shared through transboundary water systems. South Africa shares four major river systems with six neighbouring countries, namely: Botswana, Lesotho, Mozambique, Namibia, Swaziland and Zimbabwe. International agreements on water sharing are in place in all these river basins, in line with the *Revised Protocol on Shared Watercourses in the Southern African Development Community* (NWRS, 2013). Developing large-scale infrastructure to manage water use and avoid water "ownership" conflicts is a huge challenge and a key ingredient for economic growth and to manage transboundary water conflicts.

ESD and interconnected planning – the food, water and energy nexus

Water, energy and food are essential for human life and they are all interconnected. For example, water is needed in agriculture to ensure food security and water is needed to produce energy (e.g. cooling towers at coal fired power stations). Food production is also very water intensive, for example when raw materials are processed and transported to the consumer. Consider that to produce one piece of steak utilises 3 000 litres of water (calculated in terms of the water needed to feed the animal and to process and transport

the meat). With 70% of the expected global population of 9.2 billion people living in cities by 2050 and with economic growth continuing on current paths, demands for water, energy and food will increase exponentially. There are projections of a 70% increase in agricultural demand by 2050 and energy demand increase of 40% by 2030. Water demand projections to satisfy agriculture and energy production are similar. (Bonn Policy recommendations, 2011).

The diagram alongside shows an integrated model of Sustainable Development reflecting that the ecological sphere (ecological infrastructure) supports all other spheres. This relates to the interconnected thinking required in understanding the food, water and energy nexus.



Source: Adapted from Hattingh, 2004

With a growing population and growing demands on food, water and energy, it is essential that planning in each of these sectors be considered in an interconnected way. A shortage of water could have very negative consequences on energy and food production. If energy planning and agricultural growth takes place in ways that stress available water, the whole system could collapse. It is projected that South Africa's population will grow from the current 49 million in 2013 to approximately 53 million people by 2025 (StatsSA, 2006). An implication of this in terms of growing water demand is that domestic water use will increase from 27% in 2009 to between 30-35% of total national use, combined with the fact that food production will have to increase in order to provide food for the national population as well as for the global population explosion (a global population of 9 billion by 2050) in the form of exported food and goods produced from the agricultural sector. With a growing population and rising risk and uncertainty in the agricultural sector as a result of climate change, this becomes a very complex task. It is suggested that nexus thinking is critical for sustainable living.

The water and food nexus

Food security refers to a situation in which individuals, households, communities and governments have access to sufficient food of good quality. Unfortunately in Africa most people live in a state of food insecurity as they live in poverty and in fear of starvation. 3.1 million children die each year from poor nutrition (World Food Programme, 2013) and hunger kills more people than deaths from HIV, malaria and TB combined. The reason for this is not a lack of available food for the world's population; it is more complex and relates to inequities in distribution of food, which is in turn related to water availability and distribution for crop production. In South Africa, commercial agriculture for food production relies on water intensive irrigation schemes and in terms of water sector usage, accounts for 60% of all water usage. There will be further strain on water availability for food security in the future as the irrigation strategy of South Africa has set a target of an increase of more than 50% of irrigated land (NWRS, 2013).

Water and Livelihoods is a key issue in South Africa and forms part of the South African NWRS2 which has identified the need to redress imbalances in water distribution and to invest in providing water and water infrastructure in rural areas. The Department of Water Affairs is currently developing a strategy to provide financial support for the creation of water based, vibrant, equitable and sustainable rural communities and food security for all. The Development Bank of South Africa (DBSA) in its *Water Security in South Africa* report (2009) states that "water should be used productively and efficiently to improve as many livelihoods as possible". Africa is home to almost 2 billion people and 70% of the continent's

population depends on agriculture for its livelihood. The majority of African farmers are subsistence farmers who depend on natural rainfall rather than irrigation to water their crops. They use very little technology. Securing livelihoods would be a combination of both addressing water distribution and also irrigation technologies. The DBSA report states that in some cases where water distribution and availability has been addressed, there has been poor uptake of technologies to improve food production. The DBSA report further states that the reallocation of water would also improve employment levels.

Factors likely to impact on food and water security

Population
Although South Africa's population is not growing rapidly because of AIDS and emigration, population issues have had a negative effect on the resources that the country needs to combat the threat of food and water insecurity.

Unemployment
Unemployment rates in townships outside the cities are about 57%, which is a major contributing factor to South Africa's urban food insecurity.

Inequality
Different sections of the population are faced with varied circumstances in education, employment, health and nutrition. Despite government feeding schemes, malnutrition rates among children have not improved since democratic change in 1994. One quarter of females in the country do not have adequate levels of nutrition.

Rising prices
In recent years, the average price of food items in South Africa has been increasing faster than the economy's consumer inflation level. Rising prices are linked to rising world energy prices, which impacts on the food supply chain. It is this, rather than a shortage of food supply, that renders millions of South Africans food insecure.

Access to food markets
Regulations pertaining to informal food vending limit purchase and sale opportunities as well as the variety of food available to many urban dwellers.

Urbanisation
South Africa's urban dwellers comprise 60% of the population and the poorer settlements do not yet have access to services.

The water and energy nexus

World Water Day 2014 addressed the nexus of water and energy. It was coordinated by the United Nations University (UNU) and the United Nations Industrial Development Organisation (UNIDO) on behalf of UN-Water.

Water and energy are closely interlinked and interdependent. Energy generation and transmission requires utilisation of water resources, particularly for hydroelectric, nuclear, and thermal energy sources. Recent interest in biofuels has also increased demand on water resources with the latest World Water Development Report (2012) predicting that even a nominal increase in biofuel demand (say 5% of road transport by 2030, as predicted by International Energy Agency) could push up the water demand by as much as 20% of the water used for agriculture worldwide (UN Water website download, 2013). Additionally, biofuel production is linked to increases in water pollution through increased used of fertilisers and agricultural chemicals. Conversely, about 8% of the global energy generation is used for pumping, treating and transporting water to various consumers.

Consider that during 2011 Eskom used 327 billion litres of fresh water, amounting to 10 000 litres of water per second. A single person using the minimum of 25 litres of water per day would amount to 9 125 litres of water per year or a household using the minimum 6 000 litres of water per month would amount to 72 000 litres of water per year.

Water in coal mining is not only used for cooling processes but also in road wetting for dust suppression and coal washing. Any water that comes into contact with disturbed areas on the mine is known as 'dirty water' and if it is not used in the coal producing process is pumped into slurry dams, or released into river systems. During all these processes evaporation of water also occurs.

Energy production capacity is expected to increase in South Africa as Eskom is currently building three new coal fired power stations to provide for South Africa's growing energy demands. The production of energy also should include consideration for the impact of coal mining on water needed to drive the turbines and the impact that coal mining activities are having on water quality and availability. If one considers energy production in terms of the inputs needed, this is a very water intensive sector.

Did you know? Almost 90% of South Africa's electricity is generated in coal-fired power stations. Koeberg, a large nuclear-powered station near Cape Town, provides about 5% of capacity. A further 5% is provided by hydroelectric and pumped storage schemes.

Manufacturing and industrial usage of water

The table below shows the amount of water for production by various industries that are found in the SADC region.

Industry	Unit of product	Water requirement in litres
Bread	Tonne	2 100–4 200
Beer	Kilolitre	15 000
Milk products	Tonne	20 000
Wood pulp	Tonne of pulp and paper	236 000
Cotton bleaching	Tonne	300 000
Gasoline	Kilolitre	7 000–10 000
Steel	Tonne	26 000
Sulphuric acid	Tonne of 100% H_2SO_4	10 400

Source: SADC, 2002. *Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa*, p.143.

Expanding knowledge

The following are interesting resources that present relevant information in an understandable way.

Hyperlinks

www.dwaf.gov.za/nwrs/ – National Water Resources Strategy: Managing water – an equitable and sustainable future website for the full and latest NWRS as well as a summary document and resources to understand water resources in SA.

http://www.dwaf.gov.za/WFGD/documents/WfGDv6Nov21.pdf – Water for Growth and

Development in South Africa, Department of Water Affairs and Forestry – A comprehensive report on the current and future challenges to South Africa's water security.

http://africasd.iisd.org – the International Institute for Sustainable Development website and provides Africa Regional Coverage: A knowledge base of international sustainable development activities in Africa.

www.ramsar.org – The Ramsar Convention on Wetlands (1971) is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Documentaries

The Hungry Season, directed by Matthew Brown – an 11 minute documentary on food insecurity. http://matthewbrown.tv/the-hungry-season/

Teaching Practice

In this section we explore various ways in which we can teach learners about water and development. The section starts with an activity aimed at showing the interconnectedness between water availability and development.

ACTIVITY 4

WATER AVAILABILITY AND DEVELOPMENT PATTERNS

This activity aims to show the interconnectedness between water availability and development. The activity aims to develop learners' mapping skills and to provide a spatial orientation to where the development in South Africa has taken place in relation to the areas of water availability. This can either be an atlas activity or, if your school has access to computers and GIS software, can be incorporated in a lesson used to orientate learners to the use of GIS data layers.

Method used: Information transfer

See page 11 in the *Methods and Processes* booklet.

Learners are engaged in a mapping task where they translate information from one form to another to develop a new form of knowledge to show the interconnectedness.

Links to CAPS

This activity helps to develop the following knowledge, skills and attitudes described in CAPS:

- Describing and explaining the dynamic interrelationship between the physical and human worlds;
- Practising essential transferable skills;
- Processing, interpreting and evaluating data ;
- Using atlases; and
- Geographical Information Systems.

More specifically, this activity uses overlaid maps from which learners make observations and give descriptions, leading to analysis and explanation.

The CAPS topic that links directly to this activity is the Grade 10, Term 3 topic of Population distribution and density.

Core knowledge

Core knowledge around water distribution in South Africa can be found in Activity 1, in Unit 1: Where is the water in South Africa?

Factors affecting population density

FACTOR	HIGH DENSITY POPULATION	LOW DENSITY POPULATION
Physical landscape	low-lying flat	mountainous/waterlogged
Climate	moderate rainfall and temperatures	too much or too little rain and too hot or too cold
Soil type	favouring agriculture	not good for agriculture
Mineral resources	abundant and valuable	poor or none
Accessibility	along trade routes	not on trade routes

Outline of activity

1. Learners trace a South African map from their atlases showing population distribution and density for South Africa.
2. Overlay these maps onto the maps in their atlases showing rainfall. (Learners can use their maps from Unit 1, Activity 1: Where is the water in South Africa?)
3. Discuss: What can you observe when you compare population and rainfall distribution in South Africa?
4. Consider the factors affecting population density listed above. Discuss how each of the above factors has influenced the population distribution in South Africa.
5. Copy the table and give South African examples of areas or towns that illustrate how the factors have influenced population distribution and density. For example, the abundant mineral resources in Gauteng have resulted in high density population and development.

Assessment

Learners should observe that rainfall patterns in South Africa are an almost perfect match for the population distribution patterns. Notable exceptions have occurred where the richness of mineral resources have overshadowed the limitations of too little water.

All settlement has been influenced by the factors listed in the table above. Some examples are given below.

FACTOR	HIGH DENSITY POPULATION	LOW DENSITY POPULATION
Physical landscape	low-lying flat e.g. Port Elizabeth	mountainous/waterlogged e.g. Drakensberg mountains
Climate	moderate rainfall and temperatures e.g. Western Cape	too much or too little rain and too hot or too cold e.g. Northern Cape has little rain and temperature extremes
Soil type	favouring agriculture e.g. south coastal plain	not good for agriculture e.g. Succulent Karoo
Mineral resources	abundant and valuable e.g. Gauteng	poor or none e.g. Western Cape
Accessibility	along trade routes e.g. Durban	not on trade routes e.g. Tankwa Karoo

Developing your teaching practice

Explore GIS software such as ESRI and see how you could apply it to this activity. Design a worksheet of steps and questions for learners to complete the activity using the GIS software.

ACTIVITY 5

WATER RESOURCES AND DEVELOPMENT

This is a critical thinking activity that enables learners to think “deep and long” rather than viewing water use and water management and planning in the short term. This is to realise some of the goals of ESD, namely to develop an awareness that current decisions have an impact on future generations. The backward mapping exercise will help the learners to “imagine the future we want” and to really grapple with the tough decisions that would have to be made if we are to achieve this.

Method used: Scenario Planning and Backward Mapping

See page 35 in the *Methods and Processes* booklet.

This activity can be undertaken in two possible ways: firstly, using the methodology of scenario planning where learners imagine different possible futures based on how we manage and utilise water, and secondly, as a "backward mapping exercise" where learners imagine the future they would like to have and then work backwards to identify the necessary steps to achieve the desired future.

In the scenario planning activity learners will need to recognise that there are multiple points of view, for example water scenarios could be based on high water usage for increased agriculture and mining needs, whereas a second scenario could be based on strong water demand management which places limits on development.

This activity explores the use of methods that support education for sustainable development objectives. These methods help learners to explore their values and attitudes and ethical beliefs regarding water and the links to human development, economics, politics and environmental impacts, thereby developing critical thinking and problem solving skills.

Links to CAPS

This activity helps to develop the following knowledge, skills, attitudes and values as described in CAPS:

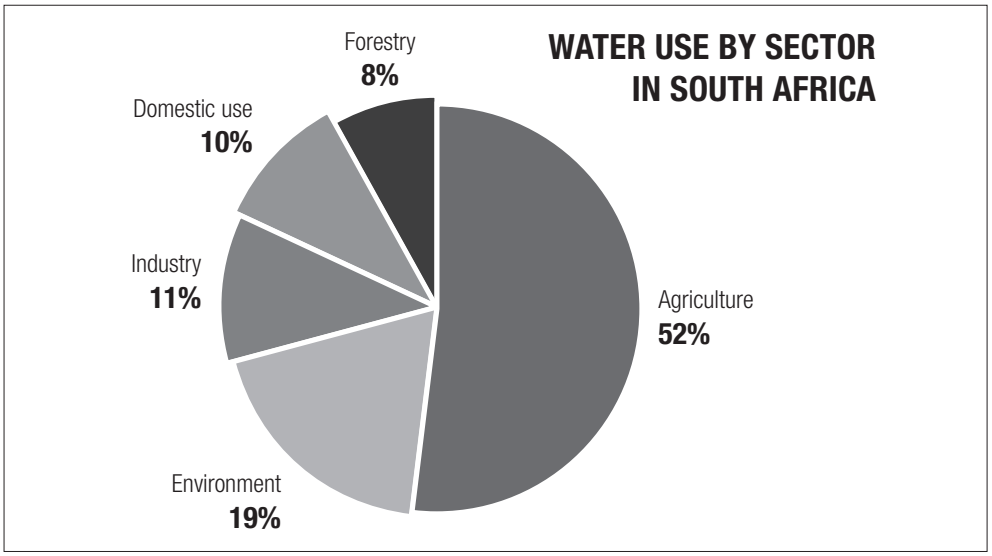
- Understanding the socio-ecological dimensions of water management and planning;
- Catchment management and water resource management;
- Respect for the rights of all people;
- A concern for the sustainable and fair use of resources for the benefit of all;
- Making decisions and judgements; and
- Futures thinking.

The CAPS topic that links directly to this activity is Grade 10, Term 4 Water Resources: Water management in South Africa.

Core knowledge

Water use by sector in South Africa

There is an estimated 21 billion m^3 of water available in South Africa. The available water use by sector is shown in the pie chart below. Refer also to the core knowledge section at the beginning of this unit.



Source: Department of Water Affairs and Forestry

Scenario Planning Activity Outline

1. *Identify a focal issue*, and decide on the key question to be answered by the analysis. Examples are: Can we pursue development objectives such as fracking licenses in the Karoo? Can we upscale the use of water for irrigation purposes by 50%? What would the water demand be if urban centres in South Africa increased exponentially in population size?
2. *Set the time and scope of the analysis*. Take into consideration how quickly changes have happened in the past, and try to assess to what degree it is possible to predict common trends in demographics. A usual timeframe can be five to ten years.
3. *Identify major stakeholders*. Decide who will be affected and who has an interest in the possible outcomes. Identify their current interests, whether and why these interests have changed over time in the past.
4. *Find key uncertainties*. Map the driving forces on two axes (those factors that will affect water usage and water availability), assessing each force on an uncertain/(relatively) predictable and important/unimportant scale. All driving forces that are considered unimportant are discarded. Important driving forces that are relatively predictable can be included in any scenario, e.g. population growth rates, impacts of climate change on water availability, increased demand for products, consumerism, job creation, etc.). This leaves you with a number of important and unpredictable driving forces.
5. *Define the scenarios*, plotting them on a grid if possible. Usually, two to four scenarios are constructed.
6. *Write out the scenarios*. Narrate what has happened and what the reasons can be for the proposed situation. Try to include good reasons why the changes have occurred as this helps the further analysis. Finally, give each scenario a descriptive (and catchy) name to make later reference easy.
7. *Assess the scenarios*. What have been the key factors affecting the scenarios? Have there been any unexpected outcomes?

Assessment

Higher order critical thinking and problem solving. The scenario planning exercise could be used as the basis for a short examination question where learners would need to respond to answering a question on what the scenario would be if, for example, South Africa adopted an economic growth without constraints model for development

Developing your Teaching Practice

Ensure that you are familiar with how to structure a scenario planning activity. It would be useful to consult with various water experts or to arrange for them to speak to your learners about water management. Additional readings for learners may also be useful for this exercise.

ACTIVITY 6

THE IMPACT OF CLIMATE CHANGE ON THE WATER, FOOD, ENERGY NEXUS

This activity aims to highlight the key challenges and links between food, water, energy and climate change. By unpacking issues and identifying variables, learners explore water issues as part of a greater overall picture. This activity has been adapted from the activity detailed in *EnviroTeach*, vol 21, November 2013, p.27 'Analysis of a case study: Nexus between food, energy and water'.

Method used: Information transfer

See page 11 in the *Methods and Processes* booklet.

Learners are given questions to guide their research and exploration of issues.

Links to CAPS

This activity helps to develop the following knowledge, skills and attitudes described in CAPS:

- Describing and explaining the dynamic interrelationship between the physical and human worlds;
- Using verbal, quantitative and symbolic data forms such as text, pictures, graphs, tables, diagrams and maps;
- Practising the following specific skills
  - identifying questions and issues;
  - collecting and structuring information;
  - processing, interpreting and evaluating data;
  - making decisions and judgements;
  - deciding on a point of view;
  - suggesting solutions to problems; and
  - working co-operatively and independently.

The CAPS topics that link directly to this activity are:

- Grade 10, Term 1 The Atmosphere: Heating of the Atmosphere
- Grade 10, Term 4 Water Resources: Water management in South Africa
- Grade 11, Term 1 Africa's weather and climate; Droughts and Desertification
- Grade 11, Term 4 Resources and sustainability: Energy management in South Africa
- Grade 12, Term 3 Economic geography of South Africa: Agriculture

Core knowledge

A nexus approach enables us to understand connections and relationships between all the elements of a system.

> "The issue we face in modern day society is we forget the inherent linkages between water,energy, and food. We tend to look at shortages of each of these resources in isolation and try to fix them without fully understanding the impact of our actions. For example, if we want to produce food in a location where the natural ecosystem cannot support our favourite crops, we 'fix' the problem by pumping up groundwater or transporting it from long distances and mixing it with fertilizers (energy) to grow the crops. This fix usually means an incredibly inefficient redistribution of resources that ends up hurting ecosystems and debilitating the natural cycles". (Source: One Million Voices Report, UNDG. 2013).

Outline of activity

A selection of Fact sheets are provided in Appendix 1 at the end of this book.

1. Work in groups of eight. Read the Fact sheet provided. Develop a mindmap on the issue chosen from the Fact sheet.
2. Split the group into pairs. Each pair chooses one topic from Food, Energy, Water or Climate Change to research further by answering the following questions:

   Energy:

   - What is the government's position in terms of energy production in South Africa?
   - What policies govern energy production and maintenance and sustainability in South Africa?
   - What are South Africa's main sources of energy?
   - Who are the largest energy users in South Africa and what percentage of energy do they use?
   - What has South Africa committed to in our National Climate Change Response White Paper?
   - How is energy influencing water issues in South Africa and vice versa?
   - What is the relationship between energy and food?
   - What influence does energy have on climate change and greenhouse gases?
   - What emerging issues on energy and food are highlighted in the article/s?

   Water:

   - What is the status of water resources in South Africa?
   - Which areas in South Africa are experiencing water challenges?
   - What policies are governing South Africa's water resources?
   - What types of activities are affecting water resources in South Africa?
   - Which are the largest users of water in South Africa?
   - What plan does the government have around water in South Africa?
   - How does water affect energy and food production?
   - How will climate change and variability affect water resources in South Africa?

   Food:

   - What percentage of South Africans are considered vulnerable with regard to food?
   - What factors are likely to affect food production in South Africa?
   - What government programmes exist currently around food production?
   - How does energy and water influence food security?
   - What is happening on the African continent with regard to food security and water?
   - How are farming practices influencing climate change?

   Climate change:

   - What is climate change?
   - How does energy relate to climate change?
   - What policies in South Africa exist around managing impacts of climate change?
   - How does climate change affect water availability?
   - How does climate change affect food production?
3. Pairs present their research to the group.
4. As a group, learners identify the key variables in the nexus as they relate to their identified issue.
5. The group prepares a presentation on their issue, highlighting the relationships and connections of the energy, food, water, climate change nexus on their issue.

Assessment

The assessment of this activity can have three steps:

1. Assessment of the mindmap produced by the group using a rubric.
2. Assessment of the research done by the pairs of learners using a memo.
3. Assessment of the presentation the group produces at the end showing the nexus connections.

Assessment practice

Task for the teacher

In each year of the FET phase, a data handling, mapwork and research/essay writing task needs to be completed for formal assessment.

Note that while these are the formal assessment tasks (assessment of learning), you may also include various assessment for learning tasks in your teaching planning. It is also essential to employ a variety of assessment methods and instruments as well which provide interesting and challenging tasks that are imaginative and engaging to the learners and yet still meet the required assessment objectives. The table below offers more ideas of possible assessment tasks.

A list of possible assessment for learning methods and instruments/tools

Assessment methods	Assessment tools/instruments
Case studies and open problems	Checklists and rubrics
Classroom based discussions	Modified essay questions (MEQs)
Computer-based assessments	Multiple choice questions (MCQs)
Direct observation	Self-assessed questions
Essays	Peer-assessed questions
Knowledge tests	Short answer questions
Learning logs/diaries	
Mini-practicals	
Orals	
Portfolios	
Poster sessions	
Presentations	
Quizzes	
Problems	
Projects	
Questionnaires and report forms	
Reflective practice assignments	
Practical demonstrations	
Reports (on practicals)	
Simulated interviews	
Multiple question examinations	
Single essay examinations	

Choose one of the activities in this unit and rework the assessment of the activity using a method chosen from the list above.

Unit 3

Action taking for water management

This Fundisa for Change unit focuses on taking action towards sustainable water use from an international, national, water catchment and community point of view. Case studies are given as examples to inspire innovation and creativity in developing solutions that would help humanity move towards the goal of water security.

The key questions addressed by this unit are:

- What policies are in place internationally and nationally?
- What role do wetlands play in water management?
- How does the country manage trans-boundary water catchment areas?
- How can we tackle water issues in our community?

Relevant CAPS topics are listed in the table below.

KEY CONCEPTS AND PROCESSES	GRADE	TERM
WATER RESOURCES ***Water management in South Africa*** ◆ rivers, lakes and dams in South Africa; ◆ factors influencing the availability of water in South Africa; ◆ challenges of providing free basic water to rural and urban communities in South Africa; ◆ the role of government – initiatives towards securing water: inter-basin transfers and building dams; ◆ the role of municipalities: provision and water purification; and ◆ strategies towards sustainable use of water – role of government and individuals.	10	4
RESOURCES AND SUSTAINABILITY ***Using resources*** ◆ the relationship between resources and economic development; ◆ exploitation and depletion of resources; and ◆ concepts of sustainability and sustainable use of resources.	11	4
GEOMORPHOLOGY ***Drainage systems in South Africa*** ◆ important concepts: drainage basin, catchment area, river system, watershed, tributary, river mouth, source, confluence, water table, surface run-off and groundwater; ◆ types of rivers: permanent, periodic, episodic and exotic; ◆ drainage patterns: dendritic, trellis, rectangular, radial, centripetal, deranged and parallel; ◆ drainage density; ◆ use of topographic maps to identify stream order and density; and ◆ discharge of a river: laminar and turbulent flow. ***Fluvial processes*** [4 hours] ◆ river profiles: transverse profile, longitudinal profile and their relationship to different stages of a river; ◆ identification and description of fluvial landforms: meanders, oxbow lakes, braided streams, floodplain, natural leveé, waterfall, rapids and delta; ◆ river grading; ◆ rejuvenation of rivers: reasons and resultant features, such as knick point, terraces and incised meanders; ◆ river capture (stream piracy): the concepts of abstraction and river capture; features associated with river capture (captor stream, captured stream, misfit stream, elbow of capture, wind gap); and superimposed and antecedent drainage patterns. ***Catchment and river management*** ◆ importance of managing drainage basins and catchment areas; ◆ impact of people on drainage basins and catchment areas; and ◆ case study of one catchment area management strategy in South Africa.	12	1

Subject Content Knowledge

Introduction

This unit starts off by documenting current international and national policies for water use. It then focuses on provincial, municipal and community based responses to water issues, including action taking as a whole school. The activities all focus on water management issues at different scales – from trans-boundary catchment management to municipal and community action taking.

Summary of subject content knowledge

Action taking: an international policy response

The Millennium Development Goals (MDGs 2000-2015) outlined the key human development goals towards which all countries committed to developing their own national policies and strategies. Goal 10 of the MDGs is to halve the number of people without access to safe drinking water by 2015. These goals were further extended during the Johannesburg Sustainable Development Summit to include water and sanitation goals. As the MDGs' timeframes are fast approaching, it is apparent that these goals have not been adequately achieved and that we are still living in a world where the basic human right to safe drinking water is still not being met for over a billion people. The United Nations (UN) has identified three indispensable elements for a water secure world, namely:

1. Universal access to water, sanitation and hygiene;
2. Water resources management and wastewater water quality management; and
3. Water cooperation (including trans-boundary water cooperation, stakeholder participation in water management ranging from citizens to policy makers to the private sector).

In order to try and meet the MDGs through action taking, the UN declared the years 2005-2015 as the International Decade for Action 'Water for Life' 2005-2015. The 'Water for Life' Decade aims to promote efforts to fulfil international commitments made on water and water-related issues by 2015. The focus is on furthering cooperation at all levels, so that the water-related goals of the Millennium Declaration, the Johannesburg Plan of Implementation of the World Summit for Sustainable Development, and Agenda 21 (an action plan for local municipalities to achieve development targets) could be achieved. The emphasis is on **action taking** as policies alone will not enable the achievement of the MDGs; all people need to become involved in action taking efforts at different scales.

As the timeframe of the MDGs nears its end, policymakers have engaged a worldwide consultative process to formulate the development goals for the next decade by 2016, which are being referred to as the **Sustainable Development Goals (SDGs)**. The suggested SDG on water is 'Water managed to sustain people and the environment' (Source: UNDG, 2013).

Action taking: a national response

The South African national response has been to support actions that seek to meet objectives of the MDGs and other international agreements on water, including actions to meet the objectives of the Decade for Action on Water. The South African National Water Resources Strategy (NWRS2, 2013) provides a comprehensive overview of the national response to water management.

In 2008, the Department of Water Affairs (DWA) started a certification scheme to encourage local municipalities to improve their water quality management and sanitation services. The **Blue Drop** certificate is for water quality and the **Green Drop** certificate for sanitation services. Programmes such as these encourage municipalities to ensure that their wastewater systems are managed in such a way as to minimise risk to public health and the environment.

Another project of National Government is the **River Health Programme**. The South African river health programme works in partnership with the Department of Water Affairs and Forestry (DWAF), the Department of Environmental Affairs and Tourism (DEAT) and the Water Research Commission (WRC) to monitor the health of South African rivers. Each province has a network of implementers who work together. They produce annual 'State-of-Rivers' reports. Various aspects of water and aquatic life health are measured and rated. This is intended to promote ecologically sound management of the rivers in order to optimise the range of goods and services they provide to people and to inform and educate the people of South Africa about the state of health of these rivers and the importance of ensuring sustained benefits from them through wise management.

National responses to water management also involve projects with an educational focus that river commissions are undertaking to help learners and communities to deepen their learning and understanding of **water and catchment management**, for example the GIZ/ Orasecom/ WESSA River Learning Box which forms one aspect of the Orasecom catchment management strategy.

Action taking: a provincial/ municipal/community based response

Municipalities and local governments adhere to national policy directives but address these through more 'local' initiatives and actions, such as through the Blue and Green Drop water monitoring reports. A key area for action taking is in Water Demand Management. Several cities and municipalities have developed plans which may include incentives for local businesses and industries to reduce water demand. A key area could be in encouraging local energy efficiencies and renewable energy technologies as energy provision is extremely water inefficient. Strategies could be to identify and share best practices that can make a water- and energy-efficient "Green Industry" and to reduce water footprints.

Municipalities and local governments can also take action through rural and community development initiatives that place emphasis on sustainability, for example the Integrated Biogas Digester System that has been implemented in the Chris Hani District Municipality. This system was implemented in a rural school with flush toilet sanitation, but where water is scarce. The system enables waste from the school toilets to be used to produce biogas for energy that is used for cooking in the school nutrition programme. Water from the biogas system is filtered through algal ponds which purify the water and render this suitable for domestic use – in this case for watering the school food gardens. Organic material from the digester is free from microbial contamination as the biogas digester breaks down these

contaminants and can be used as fertiliser for the gardens. This is another example which links to the food, water and energy nexus where waste input is used to produce organic fertiliser and to purify "black water" so that it is suitable for domestic use.

Non governmental organisations (NGOs) and community based organisations (CBOs) also play a vital role in local action taking. An example is the the ***Duzi-Umgeni Conservation Trust (DUCT).*** The uMsunduzi and Umgeni River systems in KwaZulu-Natal have become badly degraded through neglect and over-exploitation. With increasing demands on resources, poor governance and external threats such as global climate change, these river systems will be increasingly unable to support the range of aquatic, riverine and human life which is dependent on a healthy river system. DUCT works with local laboratories and Umgeni Water among others in order to monitor water quality.

Action taking: a "Whole School Development" response

The Education for Sustainable Development (ESD) or Education for Sustainability (EfS) focus of these materials takes the approach that water management and the conservation of water resources through wise use and water resources management cannot be left to government and other authorities to manage alone. We as consumers of water resources have a significant role to play in water conservation through our water use behaviour. ESD methods help to explore ways and to "open up learning spaces" that provide opportunities for learning in which learners and other members of the community (school management, other staff, parents, etc.) can be encouraged through a whole school development approach to examine and understand their water use practices, the impacts of these on others and on the environment and to develop "agency" to reflect and be reflexive in choosing and making lifestyle choices that would determine how water is used and consumed.

Developing agency is different to behaviourist approaches to education in that it is not "telling" learners which behaviours are appropriate. Rather, learners make their own decisions based on deep reflection and learning, about what is appropriate in their context. The emphasis is on transformative practices and the empowerment of the individual and community to consciously decide and work towards contextually relevant water use practices and behaviour. A 'Whole School Development' approach provides opportunities for learners to explore and reflect on their own behaviour through deep introspection and values clarification where people develop capabilities "to value their new doings and beings that make up the adaptation and/or sustainability practices" (Lotz-Sisitka, 2009: 87)

A Whole School Development approach also uses a social learning approach to teaching and learning which emphasises the value of people learning in groups as they focus on a particular environmental problem or goal. The emphasis is not only on social learning, but on social learning that is supported by propositional knowledge (the core foundational knowledge of subjects such as geography).The school is therefore an ideal context for learning as the curriculum and core knowledge in the curriculum can be supported by social learning in the context of the school, where learners "work with new ideas to develop their own ideas in day-to-day activities that we learn on our way towards more sustainable lifestyles and development paths" (Rosenberg, 2009). The WESSA Eco-Schools programme is an example of a Whole School Development programme that encourages schools to start planning their action taking by starting with a simple audit of different aspects of their "environment and sustainability practices". Eco-Schools are encouraged to think of projects that would incorporate water cooperation in the local context.

There are over 1200 schools across South Africa involved in the Eco-Schools programme. Contact your regional WESSA office to find out more or see www.wessa.org.za.

Enquiry based learning:

An example of an enquiry based learning model is the Active Learning Framework developed by Rob O'Donoghue (revised 2007), the process of which is summarised below:

1. ***Information seeking*** (reading to learn, research etc.)
2. ***Enquiry encounters*** (audits, monitoring, modeling etc.)
3. ***Action taking at school and in the community*** (whole school development, sustainability practices, education and action campaigns, special day celebrations)
4. ***Reporting ideas*** (celebrate special days, share and report on actions, involve wider community, whole school involvement)

Whole school development programmes also tend to use enquiry based learning methods. Tools such as the **mini-SASS**, an easy to learn river health biomonitoring tool, can be used to support enquiry methods. Another example of a local whole-school project is the University of KwaZulu-Natal's **Rivers Health Initiative.** This project works closely with schools, individuals and organisations in developing and promoting school-based research activities that will encourage learners to take a lifelong interest in the health of rivers and riverine environments. An example of enquiry based learning in action is the **World Water Monitoring Challenge** (WWMC) which is an international education and outreach programme that builds public awareness and involvement in protecting water resources around the world by engaging citizens to conduct basic monitoring of their local water bodies. Whole School Development approaches also encourage awareness raising activities such as the celebration of 'Special Environmental Days' which are knowledge and information sharing platforms. For example, schools could celebrate World Wetlands Day. The key objective of World Wetlands Day is to raise people's awareness of the interdependence between water and wetlands, to highlight ways to ensure the equitable sharing of water between different stakeholder groups and to understand that without wetlands there will be no water. Another key goal is to stimulate discussion and reflection regarding the need to reconsider our view of wetlands within water management and recognise that the water resource requirements of human society are delivered by and through wetlands.

WESSA develops an environmental calendar each year and produces a *Year of Special Days* booklet with information on each day. All Eco-Schools receive this calendar and booklet. It can also be ordered from Share-Net (WESSA) – see www.sharenet.org.za for an order form or to download resources for free.

Popular water sustainability practices at school could include:

- Implementing a "greywater" collection system at school from school handwash basins and feeding this into the school garden
- Encouraging 'water wise' gardening and removal of alien and exotic plants
- Installing 'JoJo' water collection tanks to refill school toilet flushing systems and to water food gardens
- Rehabilitating local wetlands
- Installing 'low flow' and 'stop flow' taps on water basins
- Reporting and repairing water leaks quickly and efficiently, etc.

Expanding knowledge

The following are interesting resources that present relevant information in an understandable way.

Hyperlinks

http://www.worldwewant2015.org/millionvoices – A million voices: The world we want – A report by the United Nations Development Group on a survey conducted on moving towards a common sustainable future.

http://sustainabledevelopment.un.org/owg.html – United Nations Sustainable Development Knowledge Platform – updates to the open working group on sustainable development goals.

http://www.unwater.org/waterforlife.html#sthash.gDAhcTpQ.dpuf – more resources on the International Decade for Action 'Water for Life' 2005-2015.

www.dwa.gov/nwrs2012 – The South African National Water Resources Strategy (NWRS2, 2013) provides a comprehensive overview of the National response to water management.

http://www.dwaf.gov.za/iwqs/rhp/state_of_rivers.html – South African River Health Programme, State of Rivers report

http://www.orangesenqurak.com – The Orange-Senqu River Awareness Kit. Included within the Orange-Senqu RAK are self-learning resources, supported by interactive visualisation tools, maps, documents and Google Earth layers.

http://wis.orasecom.org/content/study/UNDP-GEF/general/Documents/Publications/SourceToSea/from-source-to-sea-2013-ed3.pdf – Orasecom Orange-Senqu River Commission From Source to Sea has many maps, diagrams and photos and is easy to read.

http://www.duct.org.za/ – Duzi-Umgeni Conservation Trust

lynn@ecology.co.za – Contact Lynn Hurry at UKZN for more information on the University of KwaZulu-Natal's Rivers Health Initiative.

http://www.worldwatermonitoringday.org/ – World Water Monitoring Day programme resources

www.wetand.org.za – Mondi Wetlands Programme

www.wetlands.sanbi.org – Working for Wetlands honours South Africa's commitments to international agreements, especially the Ramsar Convention on Wetlands.

sharenet@wessa.co.za – to order wetland resources from WESSA such as Wetlands pack; Vlei and Marsh Wetlands; Wetlands and People.

http://www.srhp.wozaonline.co.za/home – The Schools and Citizens River Health Programme is open to anyone who would like to participate and has access to a phone to send a photograph and start an Iceberg Conversation via www.flickr.com to a Mathuba mentor who will post your submission onto the Mathuba Google Earth site. Thereafter you can view your own submission and others by following the instructions on the Mathuba Google Earth tab.

World Wetlands Day

World Wetlands Day is recognised and celebrated internationally and nationally every year during the first week of February and is an important opportunity to highlight the importance of wetlands as well as take action around a wetland, whether with a clean-up, field excursion or taking action to formally protect it.

Additional resources

- The Orange-Senqu River Learning Box (Action Learning for a Living River) is an innovative and creative education response to the sustainable water resources management needs of the Orange-Senqu River Basin. The learning box can be used for water education in other areas too and is not limited to the Orange-Senqu river basin.
- Enviro Facts on Wetlands resources produced by WESSA Share-Net

Teaching practice

In this section we explore various ways in which we can teach learners about water management and sustainability practices. The section starts with a consideration of the role of wetlands and their management as an integral part of catchment management and securing water. Conducting an investigation is an alternative way to help learners to both accumulate information about a topic, and to get a wider variety of views, ideas and conclusions about that topic than a more direct form of information transfer would allow. It also supports learners in developing their research, data collection and analysis, and communication skills.

ACTIVITY 7

WHY DO WE NEED WETLANDS?

This activity provides learners with the opportunity to investigate and understand the importance of wetlands in ecosystems as well as how they function and why it is critical that we protect them. The activity aims to simulate some of the processes in wetlands through the building of a model. Learners work in groups to explore how the omission of different elements in the model impact on its functioning. The activity can be supported by the Enviro Facts on Wetlands materials printed by WESSA Share-Net.

Method used: Investigative methods – Investigations and experiments

See page 24 in the *Methods and Processes* booklet.

Using investigative methods allows learners to research and explore wetlands in various ways. Good investigations help learners to collect information from different sources (such as observing examples of wetlands, building a model of how wetlands function). Conducting an investigation is an alternative way to help learners to both accumulate information about a topic, and to get a wider variety of views, ideas and conclusions about that topic than a more direct form of information transfer would allow. It also supports learners in developing their research, data collection and analysis, and communication skills.

Links to CAPS

This activity helps to develop the following knowledge and skills as described in CAPS:

- Identifying questions and issues;
- Collecting and structuring information;
- Processing, interpreting and evaluating data; and
- Making decisions and judgements.

The CAPS topics that link to this activity are:

- Grade 10, Term 4, Water management in South Africa: factors influencing the availability of water in South Africa
- Grade 12, Term 1, Geomorphology: Drainage systems in South Africa

Core knowledge

Wetlands are a critical part of the water cycle in terms of water storage and purification. In terms of water management in South Africa wetlands are regarded as one of the most critical ecosystems that need to be protected in order to ensure a sustainable water supply.

Flooding and management of our water supply is dependent on the presence or absence of wetlands.

What is a wetland?

Wetlands are difficult to define because of their great variation in size and location. Marshes, bogs, swamps and vleis are examples of wetlands.

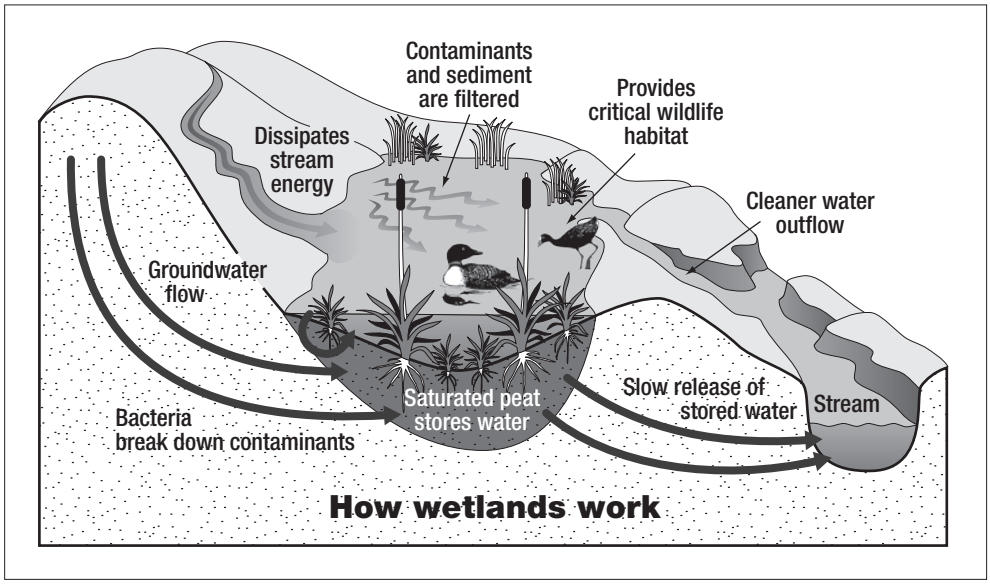
Some distinguishing features of wetlands:

- The water table of a wetland is always at or near the ground surface so that they are covered with a shallow layer of water (permanently or seasonally).
- They have hydromorphic soils, i.e. soils that have built up in the presence of excess water.
- They have hydrophytes or water-loving vegetation adapted to water-saturated soils.
- Wetlands in grassland areas usually have gentle slopes which allow water to collect.
- They are home to a wide range of amphibians, aquatic birds, snakes and tortoises, many of which are threatened or endangered. Wetlands in South Africa provide an essential habitat for three of the world's 15 crane species. All three species are also endangered.

From left: Crowned crane, Wattled crane, and Blue crane (our national bird).

Important functions of wetlands

Wetlands are often described as sponges, as they store and filter water, cleaning it. There is evidence that wetlands are able to remove a portion of the heavy metal component of water. Once water from the catchment flows into a dam or a reservoir it will have passed through a number of wetland systems that have served to regulate the flow of water and to purify it.



Source: Adapted fromhttp://nmfarmgirl.umwblogs.org/2013/02/22/preserve-the-wetlands-to-reap-the-benefits/

Main threats to wetlands

Of 792 wetland ecosystems in South Africa, 65% have been identified as threatened and 48% as critically endangered. Some of these threats are caused by:

- Drainage of wetlands for pastures and crops;
- Overgrazing and incorrect burning regimes of grasslands/ wetland grasses;
- Timber production;
- Incorrect siting of dams and over abstraction (draining of water for other purposes);
- Road building;
- Pollution;
- Mining; and
- Urban development.

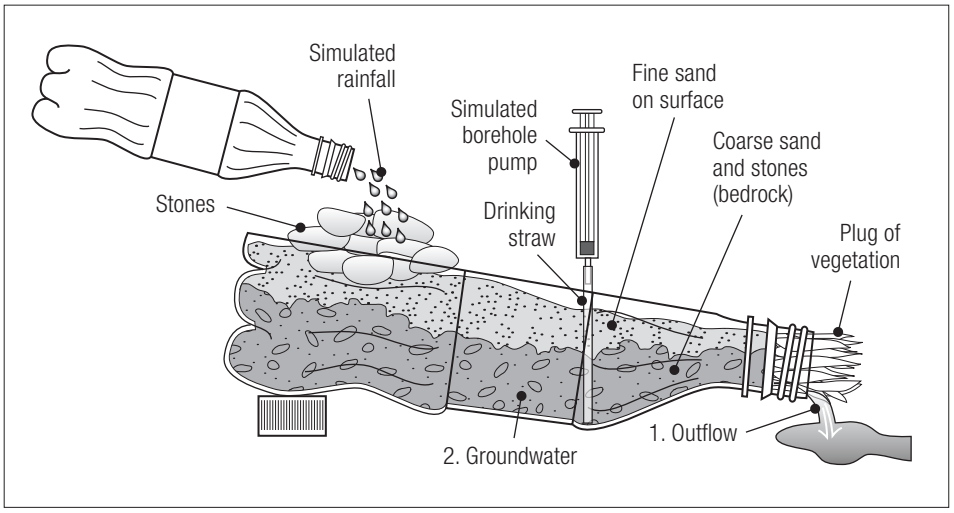
Wetland protection and rehabilitation

In arid countries such as South Africa, where water is already a critical resource, the protection and rehabilitation of wetlands is crucial and they are regarded as the most important ecosystems to consider when it comes to water conservation for reasons mentioned above. One example of a government programme that aims to help with the protection and rehabilitation of wetlands is 'Working for Water' which is a partnership approach to the rehabilitation, protection and sustainable use of wetlands.

Outline of activity

1. Introduce the activity by describing the function and importance of wetlands. Ask what the learners understand by the term 'wetlands' and how they fit into the hydrological cycle. Refer to the information supplied.
2. Build a model of a wetland using an old plastic coke bottle as shown below. The model can be used to identify the functionality of wetlands i.e. water storage, water purification, flood attenuation (slowing down water flow).

How to make a Model Wetland



Source: Adapted from Share-Net (date unknown). SWAP Starter Kit.

What you will need

2 litre coke bottles, course sand, fine sand, small stones, dry grass/vegetation cuttings, a bowl, syringe, drinking straws, old sponge.

Method

1. Cut the 2 litre bottle in half along the length without damaging the neck of the bottle.
2. Plug the neck of the bottle with grass clippings.
3. Fill the bottom of the bottle with the coarse sand. (A sponge can be used instead of sand.)
4. Put a layer of fine sand on top of the coarse sand.
5. Pack the stones in a little heap near to the fat end of the bottle.
6. Now put the fat end of the bottle on top of the lid of the bottle and rest the neck of the bottle in a little bowl in such a way that the bottle is at an angle going down towards the neck. The bottle has to be at an angle so that the water will run down from the fat end towards the neck of the bottle and into the bowl.
7. Slowly pour water over the rocks in the "wetland". Watch through the see-through sides of the bottle to see what happens. See how the water level in the sand rises. This can be compared to groundwater in a real wetland. Try this with 'murky' water that has been mixed with soil.
8. Suck up water with the syringe 'borehole' and calculate the amount.
9. Measure the outflow at the neck of the bottle.
10. Calculate the amount of water retained as 'ground water'.
11. Add another borehole closer to the watershed and work out other experiments to show how a wetland works.

Variations on the experiment:

The idea of the model is to simulate some of the processes in wetlands. Get learners to work in groups to develop a few variations on the above model to see how the omission of different elements in the model will affect:

- rate of flow,
- turbidity of the water,
- quality of the water,
- availability of ground water.

Variation ideas:

- Wetlands are known to slow water down (attenuate) during flooding, so try removing the 'vegetation' and observe the difference in speed in outflow as well as clarity of the water.
- Remove one of the soil types or use only one soil type, to demonstrate a difference in flow and turbidity. Investigate how having only a clay/sandy soil affects flow.
- Covering the 'surface' with a hard substance will demonstrate the effect when wetlands are converted into urban structures like roads i.e. showing how fast, flowing water, that is no longer being slowed down by elements such as vegetation, are more destructive while at the same time reducing the amount of groundwater recharge.
- Add more 'boreholes' to the experiment and observe the impact of extracting more water from the system.

Follow-up activities

If time allows, learners could go out and investigate and observe a real example of a wetland and write up a report. If there is no wetland nearby, or as a follow-up to an excursion, learners could discuss and draw up a table on the following threats to wetlands and their possible solutions:

- Using too much water
- Draining wetlands
- Poor land use/overgrazing

- Pollution
- Poor urban planning
- Misunderstanding about wetlands being wastelands

Assessment

In groups learners should write up a page report on their findings noting the specific conditions that pertained to their experiment. They should also note the impacts of the variations to their experiment and how these could be addressed. It is important that they report on the value of a wetland as a result of this investigation.

Developing your teaching practice

Develop a rubric to assess the model that the learners build. Draw on your own experience and challenges of building the model.

ACTIVITY 8

CASE STUDY: THE ORANGE-SENQU RIVER DRAINAGE BASIN

This activity aims to highlight the importance of the Orange-Senqu drainage basin in southern Africa and critically examines the management of this river system.

Method used: Information transfer

See page 11 in the *Methods and Processes* booklet.

Learners are engaged in a number of tasks where they translate information from one form to another, drawing on prior knowledge and attitudes to the natural environment to construct the knowledge into new forms.

Links to CAPS

This activity helps to develop the following Geography aims:

- Describing and explaining the dynamic interrelationship between the physical and human worlds; and
- Practising essential transferable skills – literacy, numeracy oracy and graphicacy.

In addition, the following cognitive and practical process skills described in CAPS are developed:

- Accessing and recalling information;
- Interpreting information; and
- Communication.

More specifically the skills developed in this activity are:

- Recalling prior knowledge of the water cycle, the concept of run-off and the processes of erosion and deposition;
- Translating information from a diagram into a description;
- Identifying connections; and
- Geographical skills (using atlases and GIS).

The CAPS topics that link directly to this activity are:

- Grade 10, Term 4, Water resources: Water in the world, Water management in South Africa and Floods
- Grade 11, Term 4, Resources and sustainability: Using resources

- Grade 12, Term 1, Geomorphology: Drainage systems in South Africa, Fluvial processes and Catchment and river management

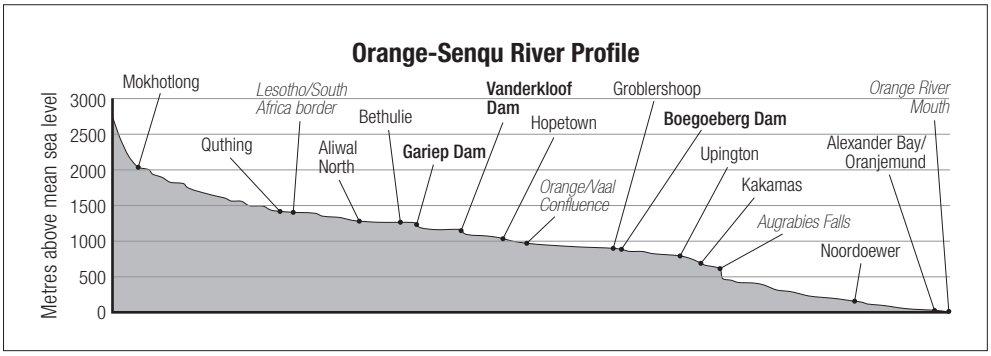
Core knowledge

Learners covered Water in South Africa in Grade 4 and Natural Resources and Conservation in South Africa in Grade 7. Introduce this activity by discussing the importance of water as natural resource and a basic need.

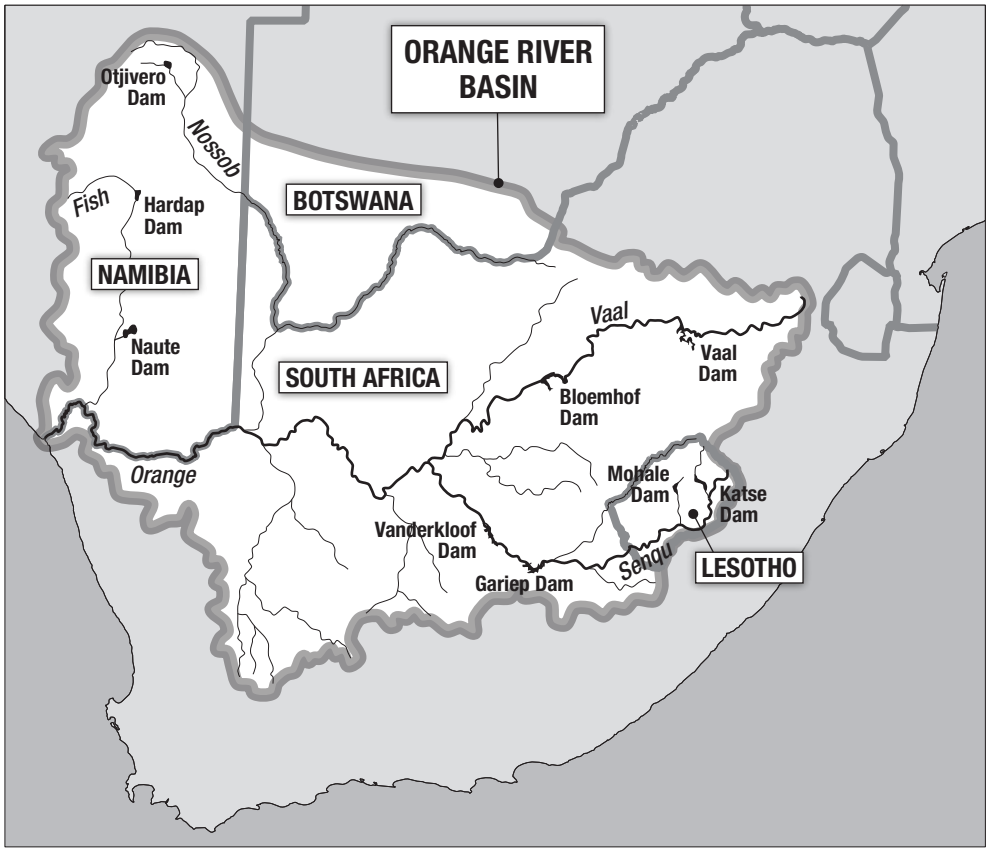
Outline of activity

Learners work in pairs. Each pair should have an atlas with rainfall distribution and population distribution maps of South Africa.

Study the two diagrams below and refer to your atlas where necessary to answer the questions that follow.



Source: Adapted from www.orangesenqurak.com

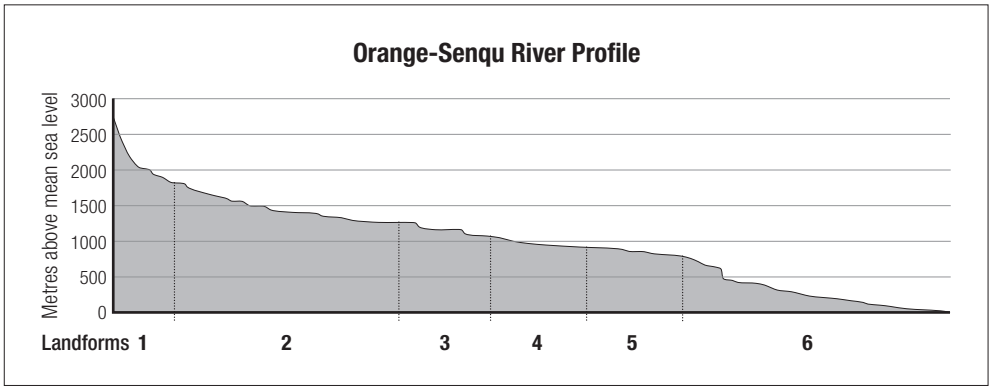


Source: WRP

1. The Orange River flows through six geographical regions.
   a) Copy the profile of the river and mark the divisions of these regions on your profile.
      1. Great escarpment mountains
      2. Highveld
      3. Nama Karoo
      4. Southern Kalahari
      5. Namaqua Highlands
      6. Southern Namib Desert
   b) In which of these regions are South Africa's two largest dams located? What are the names of these dams?
2. Name the four countries into which the Orange-Senqu River drainage basin extends.
3. Discuss why it is important that all four of these countries are involved in the management of the water in this drainage basin.
4. Describe the impacts that poor farming practices such as overgrazing and frequent burning of the veld in the Great Escarpment Mountain region could have on the water in this drainage basin.
5. There have occasionally been serious floods in this drainage basin and the area that is usually worst hit is between the towns of Douglas and Upington. Explain why this stretch of the river has the worst floods.
6. a) Trace a population distribution map of South Africa from your atlas and superimpose the drainage basin of the Orange-Senqu River onto your traced map.
   b) Comment on how the drainage basin has impacted on the population density of the country.

Assessment

1. a) The six regions should be marked roughly in the following way:



      1. Great escarpment mountains
      2. Highveld
      3. Nama Karoo
      4. Southern Kalahari
      5. Namaqua Highlands
      6. Southern Namib Desert
   b) Nama Karoo – Gariep Dam, Vanderkloof Dam
2. Lesotho, South Africa, Botswana and Namibia
3. Damming, interbasin water transfer schemes, irrigation, industry and farming practices upstream all affect the quantity and quality of water downstream. Development of and along the drainage basin needs to benefit all countries without impacting adversely on any of the countries.
4. They could lead to any of the following problems:
   - Increased soil erosion which would increase sediment load in the river reducing water quality.
   - There would be increased siltation of the dams reducing their storage capacities.

- Reduced infiltration and increased direct runoff would make the river more prone to flooding.
- Large quantities of silt would be deposited along the banks after flooding causing increased damage to farmlands and properties.
- Aquatic life and other riverine fauna and flora would be negatively affected.

5. Douglas is located at the confluence of the Modder and Vaal rivers and close to the confluence of the Orange and Vaal rivers. The portions of the drainage basin east and upstream of these confluence points receive relatively high rainfall which is also seasonal. When heavy rains fill the dams to capacity, large volumes of water flow downstream in all three systems arriving at the two confluences at much the same time. The Orange River between Douglas and Upington has many meanders and islands which cause blockages and slow the flow resulting in increased flooding.
6. Population density in the Vaal River drainage basin is the highest in the country. As one moves westwards across South Africa densities drop dramatically, largely due to the lack of water. However, densities along the Orange River are higher than areas further from the river.

Developing your teaching practice

Some of the information needed to answer the questions above is provided on the two diagrams while other information is provided by the maps in the atlas. Learners' prior knowledge is also important.

Re-design some of the questions to suit the grade and abilities of the learners you teach either by providing more background information or by facilitating discussions on water management or drainage basins. Additional background information can be found in Appendix 2.

ACTIVITY 9

ACTION TAKING AROUND WATER ISSUES IN YOUR COMMUNITY

In this activity, learners take photos of water related issues in their community using their cell phones. Working in groups they select one photo to discuss through the deliberative method of Iceberg Conversations.

See page 28 in the *Methods and Processes* booklet.

Method used: Learning by doing – Action research and community problem-solving as well as Deliberative methods: Iceberg Conversations

In this activity, learners will address local water issues using an action research process. The phase of reflection and planning will be facilitated through the use of Iceberg Conversations.

Links to CAPS

This activity helps to develop the following Geography aims:

- developing a commitment towards sustainable development;
- creating awareness and sensitivity to inequality in the world;
- ostering empathy, tolerance and fairness; and
- making and justifying informed decisions and judgements about social and environmental issues.

In addition, the following cognitive and practical process skills described in CAPS are developed:

- Identifying questions and issues;
- Collecting and structuring information;
- Interpreting information;
- Suggesting solutions to problems; and
- Communication.

The values and attitudes skills fostered in this activity are:

- A concern for the sustainable and fair use of resources for the benefit of all;
- Recognising the significance of informed decision making;
- The application of geographical knowledge and skills in learners' personal lives;
- Respect for the rights of all people; and
- A sense of fairness, sustainability and equality.

The CAPS topics that link directly to this activity are:

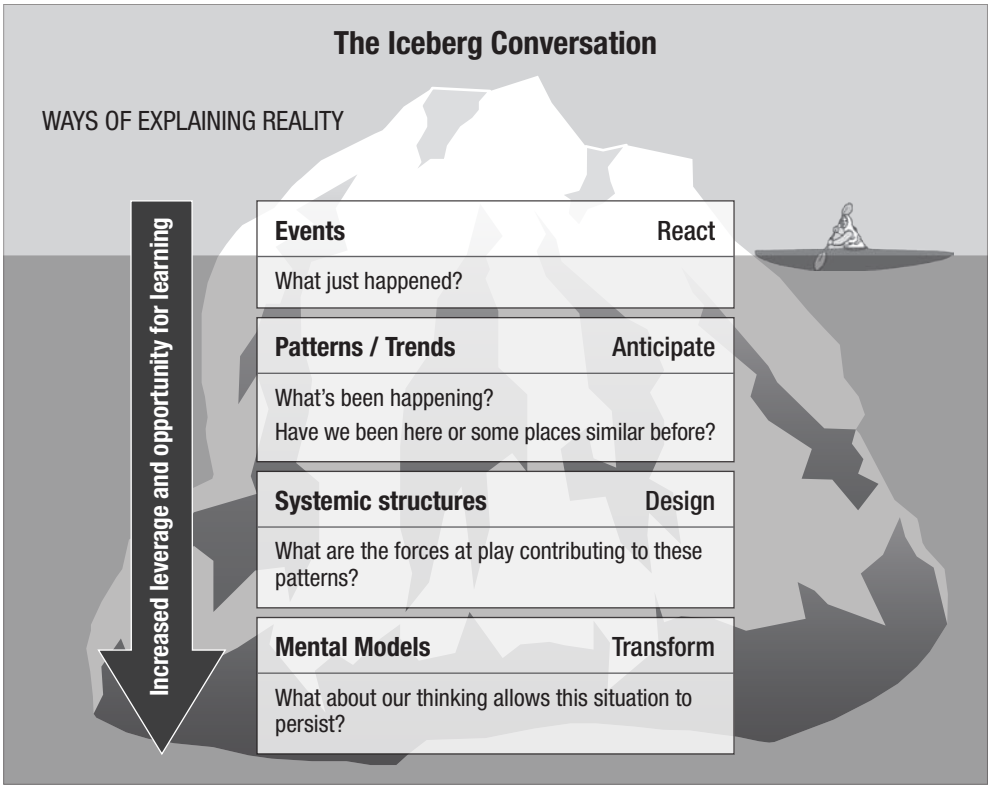
- Grade 10, Term 4, Water resources: Water management in South Africa
- Grade 11, Term 4, Resources and sustainability: Using resources
- Grade 12, Term 1, Geomorphology: Catchment and river management

Core knowledge

Iceberg Conversations

Iceberg Conversations (Senge, 2006) enable and guide deeper discussions amongst citizens around environmental issues in their areas. The metaphor of an iceberg is indicative of the invisible underlying mechanisms that drive and perpetuate visible outcomes such as solid waste pollution, sewage pollution, biodiversity loss or alien invasive plant infestation.

Model of an Iceberg Conversation that enables unpacking of issues at a deeper level



Source: Adapted from Senge, 2006

Outline of activity

1. Learners read through the example below of an Iceberg Conversation initiated by a resident of Sobantu Village in KwaZulu-Natal who decided to focus on the visible event of a spilling manhole using a photograph taken with his cell phone to provide a focus point for the conversation.

Example of Iceberg Conversation from Innocent Cele

OVERFLOWING SEWER – SOBANTU VILLAGE

As part of the University of KwaZulu-Natal based Schools and Citizens River Health Programme known as *Mathuba*.

Innocent Cele:
I took this picture on my cell phone at 15h00 on 12 December 2012, near Sobantu High school in Sikhosana Street, Sobantu Village. Latitude 29.594752 Longitude 30.42859

Events *(What is happening?)*

- The sewer manhole is overflowing.
- There are plastic bags and nappies in the sewage water.
- The sewage is running down the street past houses.
- The sewage is running from the street directly into the Baynespruit river in the distance.

Patterns, Trends and Interactions *(To raise discussion points that will help to anticipate patterns or trends, the interactions that affect them and to discuss what might prevent them from developing)*

- I have seen other manholes in the area which are also overflowing.
- This manhole has been overflowing for some weeks now.
- This manhole overflows regularly. Municipal officials only arrive to sort out the problem when my school phones them.
- Water in the Baynespruit is being used by some people for drinking and washing clothes.
- Sewage water contains E. coli and other bacteria harmful to people.

Systematic thinking *(Speculate on existing systemic forces, links and relationships that led to the event and to offer new designs to prevent re-occurrences)*

- Is it true that the local municipality is unable to manage the regular collection of rubbish bags?
- Is there a link between the poor service with regard to the clearing of black rubbish bags and the fact that many people put solid waste in their toilets?

- To what extent are roaming dogs that tear open rubbish bags part of the problem?
- How can citizens put pressure on the local municipality to pick up rubbish bags on time?
- In what ways should we be looking at the problem so that we can find solutions that work together to solve it?

Mental Models *(To consider what is happening that allows the situation to persist and to offer solutions to transform it)*

- To what extent is the local municipality not responding to the severe pollution problem?
- What do you think may be affecting the non-collection of rubbish bags by the municipality?
- What can householders do to reduce the problem of blocked sewers?
- What else can citizens due to reduce the problem?
- Would it help if the householders had metal or wooden stands on which to place their rubbish so that the dogs could not get to them?

2. Learners consider water-related issues in their community. They then venture into the community to take photos of a water-related issue using their cell phones.
3. Learners may also wish to interview members of the public, recording these interviews on their cell phones. If learners wish to conduct interviews, they need to think carefully about:
   - What are the questions they would like to ask?
   - Who do they want to ask?
   - Why do they want to ask the people they have chosen?

   Important note on ethics:

   Learners need to be informed as to the importance of
   - Setting up interviews and meetings in advance;
   - Getting permission from the interviewees to hold the interviews and use the data gathered;
   - Giving feedback to all the people who participated in the interviews.

   It is your responsibility as teacher to ensure that appropriate protocols are implemented during the course of learners conducting action research.
4. Working in groups learners select one photo that they would like to discuss through the deliberative method of Iceberg Conversations.
5. The process of action research does not end at the investigation stage. Upon analysing the findings of their research i.e. the information that the photo, their discussion and interviewees provided, learners are expected to “plan (an action), act, check (the effects of the action), reflect (on the outcomes) and then plan a follow-up action-reflection cycle” (Rosenberg et al., 2013). The proposed action need not be on a large scale, any initiative that can contribute to improving the situation counts as an action.

Assessment Practice

Tasks for the teacher

1. Investigating the usefulness of electronic resources

One of the Geography aims is promoting the use of new technologies, such as Information Communication Technology (ICT) and Geographical Information Systems (GIS). However, GIS software does not appear to be used much in schools, even in those with the technology available. However, some organisations have put a lot of money and effort into providing quality websites making use of GIS features. The Orange-Senqu River Awareness Kit is one of these. The website is supported by interactive visualisation tools, maps, documents and Google Earth layers. The website includes an interactive water cycle, maps and lots of other information.

Investigate the website www.orangesenqurak.com and discuss in groups how the website could be used by your class.

2. Enquiry Based Learning: MiniSASS mapping activity to get to know your catchment

To produce your own custom-made map of a section of your local catchment you can go to the miniSASS website, http://www.minisass.org/en/map/. Navigate on the Google Earth map to the area where your school is situated and make use of the different layer options to generate a map/s of your local catchment. There are several options for Base layers for maps: **Google terrain** showing physical geography of the area; **Google satellite** photographs (useful for identifying specific buildings, activities and land use in the catchment); **Google road map** showing roads and cities; and **Rivers and catchments** showing rivers, streams and catchments in detail.

You will need a snipping tool such as Greenshot, to capture the area that you are interested in.

Use your maps to enable your learners to become familiar with the streams in their own area and to stimulate interest in GIS activities.

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Appendices

Appendix 1

Unit 2: The Impact of Climate change on the water, food, energy nexus

Fact sheets selected from EnviroTeach Vol 21, Nov 2013, pp. 17, 18, 22, 25

FACT SHEET: EASTERN CAPE (CLEAN WATER SUPPLY)

With the increasing pressure of population on **global resources** and the imperative of **climate change** there is a growing interest in the idea of the **"Energy-Water-Food Security Nexus"**. South Africa needs to develop a tool for policy development and the planning of practical interventions. A case study in the Elundini Municipality will seek to apply a nexus- orientated framework to develop practical interventions in supplying power and piped water where it is lacking and improving current agricultural practices. The Elundini Municipality, located at the foothills of the Drakensberg Mountains in the east of the Joe Gqabi District, is known as the Eastern Cape Highlands region. It falls between the Maluti Mountains and the southern Drakensberg. There is abundant water but up to 79% of the local population has no access to **piped purified water** within 200m of their dwelling and 88% have no access to **electricity**. The challenges to communities in the area are perhaps best captured by a recent **Department of Water and Forestry Affairs Report** (BKS, 2010) "The Mzimvubu River is the catchment which simultaneously has both the most available water and the greatest poverty in South Africa. Through the ages its abundant water has cut deep, steep valleys into the landscape, creating inaccessibility and remoteness, with major challenges for travel, service provision and most land based economic activities. Even water, as abundant as it is, is essentially inaccessible." Addressing **water scarcity** and quality calls for a multi-disciplinary approach to **water resource management**. The approach needs to ensure the co-ordinated development and management of water and related resources in order to maximise economic and social welfare in an equitable manner without compromising the **sustainability of vital ecosystems**.

PROJECT: HIPPO WATER ROLLERS

The Department of Rural Development and Land Reform (DRDLR) has been given the mandate by the President of South Africa to develop and implement a ***Comprehensive Rural Development Programme (CRDP)*** throughout the country. The Hippo Water Rollers have been identified as an appropriate technology to be used on sites facing the **challenge of water supply**. The Hippo Water Roller is a container designed to transport **90 litres of water,** comprising of a drum with a large screw-on lid and a clip-on steel handle. It is able to withstand typical **rural conditions** e.g. uneven footpaths, rocks and broken bottles. The innovative design allows the water to be placed inside the "wheel" rather than carried above the wheel. 350 Hippo Water Rollers were delivered to 8 selected sites in the Eastern Cape. One site is **Mqokolweni Village,** located in the Elundini Municipality. It accommodates up to 123 600 people in 35 553 households. There is no piped water to the homes and the community relies on the Tsitsa River which requires them to walk long distances to **access water**. One Hippo Water Roller is shared amongst 3 or 4 households, showing the level of acceptance the intervention has received. Water can be fetched and be used for all house-hold activities i.e. cleaning, cooking, bathing and irrigation of backyard crops. The Hippo Water Rollers are also being used by some community members in their small businesses for the manufacturing of bricks used for building huts.
The Hippo Water Roller is an aid to transporting water from different sources to households and is not intended to replace the government's plan to supply all South Africans with water. It is an interim measure to help communities who have not yet received piped water, or where piped water is at a distance from homes.

FACT SHEET: WESTERN CAPE (TEA FARMING/FOOD SECURITY)

The Western Cape is famous for its wine and fruit production. In a region struggling with competing demands for **water** from farmers, industry and a growing urban population, **climate change** predications for even less **rainfall** in an already arid region creates a challenge in balancing **scarce water supply** with rising demands. The Western Cape's climate is Mediterranean, warm and sunny, with most rainfall during the winter months. In the last decade, the region experienced some unusual **droughts** which, in 2004-2005, cut agricultural production in many areas and led to municipal **water rationing**. Farmers growing the **honeybush tea** in Erikaville, South-Western Cape, have reported experiencing heavier, short bursts of rainfall which cause **soil erosion** among other problems. One farmer said "We used to get better yield on the slopes as honeybush grows mostly on south facing slopes in nature, but the wet soil conditions caused the crops to get root rot on the lower slopes and we lost about 30% of our crops". Tea farmers are also experiencing **higher temperatures** and **windier conditions**, factors which alter the crop production. **Rooibos** is another crop, producing over 9000 tonnes per annum, mostly limited to its natural geographical range within the **Cape Floristic Region** of the Cederberg and Sandveld areas of the Western Cape. As one farmer said "**Food security** would become a bigger problem if industries and government institutions don't do something to combat climate change". People in the food production field need to examine the **energy-water-food nexus** in order to understand its impact on South Africa's increasingly constrained supply of water and energy.

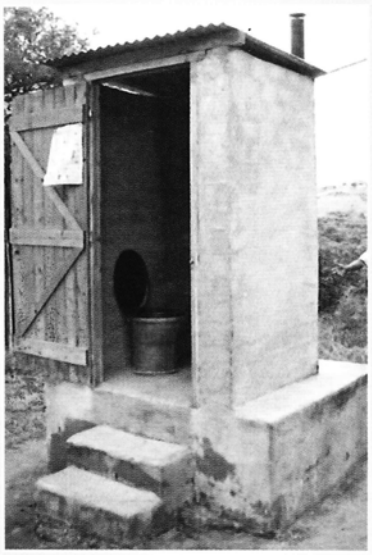
PROJECT: MAKE A CHOICE, MAKE A GREENCHOICE.

The GreenChoice project is aware of the need to understand how to address the **food, water and energy challenges** of the 21st century, "and to come together to find ways of supporting **sustainable food production**. The global reality of **food security** and of a **resource-constrained** future has hit home..." said the project manager, Tatjana von Bornmann. Business and **biodiversity** were a long way from finding each other when the WWF Nedbank Green Trust started funding the GreenChoice sustainable food production initiative in 2008. Since its implementation, GreenChoice has become involved in many food security projects. One such project is the **Right Rooibos** project. "**Rooibos** itself is a unique, **indigenous tea** within South Africa's biodiversity. It is a highly successful export product with immense impact on the fragile environment in the Cape Floristic Kingdom where it grows," says von Bornmann. In response to the **changing environmental constraints**, rooibos tea farmers and producers are now committed to better production standards in terms of managing their **water and soil health**. They have also set aside land on their farms to **conserve critical biodiversity areas**. "We have gone to great lengths to distil thinking on **sustainable agriculture**, incorporating the latest insights on **climate change** and regulatory requirements," explains von Bormann. All GreenChoice partners have collaborated in the production of the Living Farms Reference, including sustainable producers of wine, wool, honey, potatoes, rooibos tea and flowers. It's the first of its kind in Africa and possibly even in the world."Our aim was to create a set of principles for sound, **ecosystem-based farming** across all agricultural industries; with a focus on water conservation, soil health, chemical- and pollution reduction as well as a reduction in energy consumption and greenhouse gas emissions" quoted von Bornmann.

FACT SHEET: KWA-ZULU NATAL: (DECENTRALISED WASTEWATER TREATMENTS).

When discussing the **energy-water-food nexus**, Professor Chris Buckley, Head of UKZN's Pollution Research Group, said "Current global trends are **urbanisation**, **population growth** and **climate change**. Available water resources are needed for **water supply security, food security, and energy security**. The interlinking of them all is what we need to consider when we are making our choices". Buckley provided some sobering statistics: in 2004, about 3.6 billion people or 42 percent of the world's population lacked adequate **sanitation**; only 330 million people (i.e. 5 percent) had advanced sewage treatment; **malnutrition** accounted for 14 percent of the global burden of disease and sanitation-related diseases some 3.4 percent; and 32 percent of Africa's population was without reasonable access to improved **water sources** while about 60 percent were without sanitation. Durban (Zulu: *eThekwini*, from *itheku* meaning 'bay / lagoon') is the largest city in the province of KwaZulu-Natal. It is also the second most important manufacturing hub in South Africa after Johannesburg. It forms part of the eThekwini metropolitan municipality. Durban is famous for being the busiest port in South Africa and Africa. It is also seen as one of the major centres of tourism because of the city's warm subtropical climate and extensive beaches. The municipality, which includes neighbouring towns, has a population of almost 3.5 million. Many of Durban's **informal settlements** are faced with challenges such as high unemployment, poor school facilities, open defecation, large influx of people and the areas themselves are relatively rural. While central Durban had developed sanitation infrastructure, the periphery of the unicity is a far more rural environment. Durban is a municipality facing the greatest number of informal settlements where there are no formal sanitation facilities in 203 222 households and 21 469 traditional rural households.

PROJECT: DESIGNING AND CONSTRUCTING A DECENTRALISED WASTEWATER TREATMENT SYSTEM AT THE "NEWLANDS-MASHU PERMACULTURE LEARNING CENTRE".



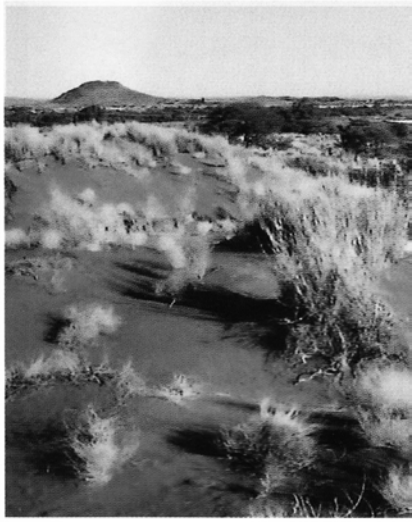
Tapping on the resources provided by **treated wastewater**, the eThekwini municipality promotes healthy communities through a holistic and sustainable approach to **urban agriculture** that embraces **organic farming** principles based on low input costs. In this context, the German non-profit "Bremen Overseas Research and Development Association" (BORDA) is collaborating with the Municipal Water and Sanitation Utility and the University of KwaZulu-Natal in designing and constructing a **decentralised wastewater treatment system** (commonly referred to as DEWATS) at the "Newlands-Mashu Permaculture Learning Centre" – one of the municipality's six support hubs under its "Agroecology Programme". The DEWATS, receiving up to 40 m^3/d of domestic wastewater from 85 households of a surrounding residential area, runs by **gravity** only - no machinery or energy inputs are required. Instead, **biogas** is collected and used for cooking. Today over 1,000 DEWATS treating 1-1,000 m3/d serve settlements, small and medium enterprises and institutions. Their potential applies to sites where population density is too big to apply individual household sanitation solutions like latrines and where a connection to the public sewer system is economically not feasible due to distance, topography or limits of the sewer network and/or the receiving treatment works. In recognition of 'BORDA's technology innovation that transforms sanitation service delivery in **low income urban settlements'**, BORDA has been announced as winner of the IWA Development Solutions Award in the 2011 cycle.

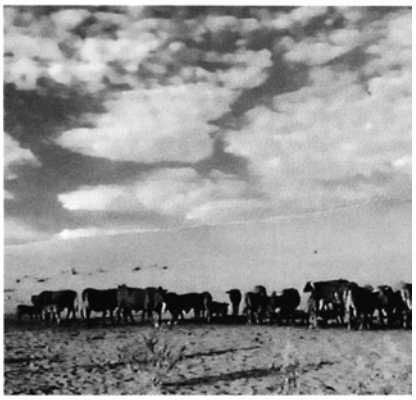
FACT SHEET: NORTHERN CAPE (FOOD SECURITY)

Food security is defined by the Food and Agricultural Organization (FAO) as "availability and access to sufficient, safe and nutritious food to meet the dietary needs and food preferences for an active and healthy life". When exploring the **energy-water-food** nexus one is confronted with the food security issue – food production is by far the largest consumer of **global fresh water supplies**. Worldwide, agriculture is responsible for up to 80% of the fresh water consumption by humans. **Food production** further impacts the water sector through **land degradation**, changes in **runoff**, disruption of **groundwater** discharge, **water quality** and **availability** of water and land for the natural habitat. The full food and supply chain claims approximately 30% of **total global energy demand**. Energy fuels land preparation, fertilizer production, irrigation and the sowing, harvesting and transportation of crops. The increase in the price of oil increases the price of food. The energy sector in the form of mining, transportation, **deforestation** for **biofuels** etc also claims land that could be used for agricultural purposes. **Climate change** will have a significant impact on food availability, food accessibility and food system's stability in many parts of the world. In 2010, Water and Environmental Affairs Minister Buyelwa Sonjica said that the Northern Cape needs to focus more on climate change, "It is anticipated that the Western Cape and Northern Cape could be the most severely impacted [by climate change]," Sonjica said at the province's water indaba, "In particular, it is predicted that Northern Cape will get hotter and drier in the decades to come".

PROJECT: FETSA TLALA PROJECT

On the 24th October 2013, in Kuruman, Northern Cape, President Jacob Zuma announced the country's national food security programme, the **Fetsa Tlala Integrated Food Production Initiative**."The thrust of Fetsa Tlala is to produce enough food to meet the population's food needs now and in the future," said the President. People are being encouraged to go back to farming, with every household developing a **food garden**, **co-operatives** focusing on vegetable production, livestock or chickens to earn a living and to fight hunger. The Fetsa Tlala Project will "...begin accelerating this journey towards **food security**, being aware of obstacles such as disasters. These include drought, veld fires and floods. The government will continue to support households to prevent and deal with weather related calamities which can impact our efforts". This announcement has brightened the mood of residents in Kuruman, one of the Northern Cape's drought-stricken areas. 2013 has been an abnormally dry year, but the Manyeding agricultural cooperative won't let that stand in the way of its **organic farming**. "(We're)... growing butternuts, spinach, etc, to sell to Pick n Pay in Kuruman and Kimberley," said project manager, Patrick Tonyane. The project provides much-needed income to its 159 beneficiaries. "Now (I) have money... and have vegetables to feed my family etc," said community member Kelebogile Moseki. With the assistance of the Department of Agriculture and its private partners, the community has also gained some business skills. "I've learned how to negotiate and about the markets, business skills etc," said community chairperson Boitshoko Moacwi. A vegetable processing and packing plant will soon become part of the operation. The department hopes the cooperative will be completely self-sufficient by next year. The Manyeding project is only the beginning for Fetsa Tlala.





The Namakwa District research project on page 26 is another useful reference.

Appendix 2

Unit 3: Catchment Management Case Study

Enviro Fact Sheet, 2012. 'The Orange-Senqu River Basin'. Howick: Share-Net. Available from www.orasecom.com

The Orange-Senqu river: life blood of the basin

The Orange River rises as the Senqu in the highlands of Lesotho, some 3,300 metres above sea level and more than 2,300 kilometres from its destination on the west coast of southern Africa. With a total catchment area of almost a million square kilometres, the Orange-Senqu River Basin is one of the largest in Africa, encompassing the whole of Lesotho, and parts of Botswana, Namibia and South Africa. Its many tributaries include the Vaal River in South Africa and the ephemeral Fish River in Namibia.

The Basin has a population of 14.3 million people, and the river system plays a vital role in sustaining livelihoods and stimulating economic growth. Water is abstracted for urban, industrial and agricultural use, and harnessed for hydroelectric power via several water transfer schemes and 29 large dams.

The combined effect of abstraction and evaporative loss has been reduction in the natural runoff of 11,600 million cubic metres per year by more than 50%. Demand for water is predicted to increase with economic growth and development, emphasising the urgency for effective water resource management to ensure sustainability.

The river is also important to regional cooperation, as it crosses boundaries and in the case of Namibia and South Africa – forms part of the border between two countries. Furthermore, each country, by way of national legislation and international conventions, is obliged to account for water allocations to other riparian countries.

The four countries in the basin are committed to working together to protect their shared water resources, and through an agreement in 2000 established the Orange-Senqu River Commission (ORASECOM) to facilitate this. ORASECOM is founded on the provisions of the Revised SADC Protocol on Shared Watercourse.

Enviro fact

The Orange-Senqu River Basin

Geography

The Orange Senqu is the largest river basin south of the Zambezi, covering an area of approximately 1 000 000 km^2. This trans-boundary river covers the entire area of Lesotho, a large part of South Africa and southern regions of Botswana and Namibia. The Senqu flows from its source near Thabana Ntlenyana (3 482 m) in the Lesotho highlands (the tenth highest peak in Africa), becomes the Orange River at the Lesotho border, traverses central and western South Africa, forms the southern border of Namibia, and finally joins the Atlantic Ocean near Alexander Bay.

The table below shows the land covered by the basin in the four riparian states of the Orange-Senqu River:

Area and percentage of the river basin for the four riparian States

Country	Area in each country(km^2)	Percentage of Basin
Botswana	79 000	7.9%
Lesotho	34 000	3.4%
Namibia	245 000	24.5%
South Africa	642 000	64.2%
Total	**1 000 000**	

Source: Orasecom, 2009

The basin is the most developed trans-boundary river basin in the SADC region, hosting much of the industrially developed parts of Southern Africa, and includes approximately 27 storage dams (Angula 2001:6). The management of water resources in the basin is required to address a host of interrelated issues, such as water quality, supply and pollution control, which will be described in more detail throughout the River Basin and Resource Management themes.

Basin landscape

The Orange-Senqu is the third largest river basin in Southern Africa, extending into four riparian states: the Republic of Botswana, the Kingdom of Lesotho, the Republic of Namibia and the Republic of South Africa. It is considered an important natural ecological link between land and water resources in Southern Africa.

Basic topography

From its source in the Highlands of Lesotho, some 3 300m above mean sea level, to the border with South Africa, the topography of the Orange-Senqu River is steep. After reaching the border the landscape is more undulating.

In Botswana, where the river does not often actually flow regularly, the Molopo sub-basin is relatively flat, with very gentle relief throughout. Topographic lows are marked by broad, flat bottomed and dry valleys. In Namibia, the major tributary of the Orange-Senqu is the non-perennial

Fish River, which when flowing, passes through deeply incised valleys before joining the main-stem Orange River close to the river mouth. Further upstream, are the Nossob and Auob Rivers that join close to the border with South Africa and Botswana, before they join the Molopo channel. Like the Molopo, these rivers flow very infrequently and surface water does not actually reach the main-stem river.

The downstream reaches of the river in South Africa, in the north western Karoo, Richtersveld and the area to the west of the Augrabies falls, often run through deeply incised valleys.

Landforms

The basin incorporates the central part of the RSA, which represents nearly half of the surface area of the RSA, the whole of Lesotho (where the main river is known as the Senqu), the southern portion of Botswana, and drains most of the southern half of Namibia.

The landforms fall into three main categories:

- **Level land**, dominating the majority of the central and western basin;
- **Sloping land**, present in the Lesotho lowlands, Highveldt and Maluti-Drakensberg, as well as the southern portion of the basin (southern Karoo); and
- **Steep land**, present along the western boundary of the basin in the Southern Namib Desert and the Maluti-Drakensberg. The steep-land category of landforms is also extensively present throughout much of Lesotho.

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