Exemplar: Water

Puzzling the quality of rivers and streams

Clean water is crucial to survival and the absence of clean water can greatly impact health, food security, and livelihoods across the world. Even today, millions of people across the world have no access to good quality drinking water. Though our planet has been bestowed with clean water, poor management and human actions have affected the water quality. Millions of children die from diseases associated with inadequate water supply and poor quality of water. In order to meet this global challenge, SDGs have committed to expand international capacity and cooperation on water and sanitation programmes.

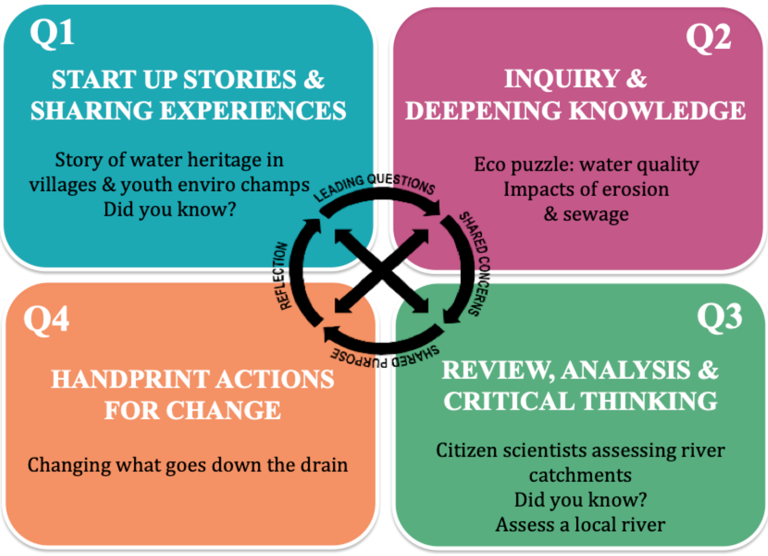
Linkage to SDGs

Water is one of the goals among 17 Sustainable Development Goals (SDGs). Clean water is the key to **Goal 6 Clean Water and Sanitation.** Through Goal 6, different countries of the world have committed to ensuring availability and sustainable management of clean water and sanitation for all. This is also connected to other SDGs including **Goal 3 Good health and well-being** as access to good drinking water will promote better health. This is also linked to **Goal 13 Reduced inequalities** as most people who have no access to good drinking water are the poor and vulnerable. By providing access to clean water, we further reduce these inequalities. **Goal 14 Life below water** is also linked to this as conserving and sustainably using seas, oceans and other marine resources is crucial to clean water.

However, water is connected to several other SDGs. In this exemplar, we are looking at the linkage of SDGs with six goals through which we work with learners to understand key issues related to quality of water and impact of humans on it. (See diagram).

Handprint CARE Pedagogy

Teachers using the Handprint CARE pedagogy could facilitate learning among students by taking them through experience sharing to inquire about the issues to critically think about what can be done and then taking actions.



Quadrant 1
Start up Stories & Sharing Experiences

Story 1: Water Heritage in Villages

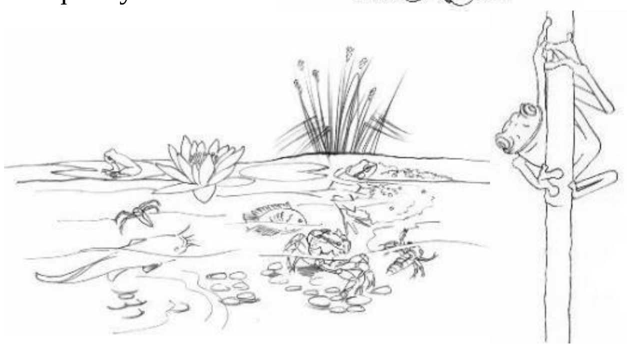
Reading water life to care for rivers and streams

People living in rural villages all over the world have been able to 'read the water quality story' in their streams and springs so as to collect clean water for their daily use.

The Nguni in southern Africa, for example, would listen out for frogs to tell them if there might be snakes around. Young women would carefully clean water pots and take care to lift '*amanzi mNandi'* (sweet water) out of a 'hole' they had cleared in the surface water of a spring.

The Xhosa cleared spring water using an ancestral practice of sprinkling wood ash on the surface, particularly during the rainy season when the water became cloudy (turbid). Wood ash is a flocculent that enables small particles of silt to be drawn together and sink to the bottom of a pool. Wood-ash flocculation would clear a pool so that it was possible to collect clear water as well as to see to the bottom of a pool for evidence of healthy organisms living in a village spring.

Today we use Mini-SASS in the same way to read water quality in a local river or stream.



Story 2: Youth Enviro-Champs

Catchment action by Mpopomeni youth

Nonthlantla was surprised when the visiting speakers from DUCT were Sbu and Mdu as they lived in her street. They told her class that sewage had been flowing into Midmar dam from Mpopomeni for more than 20 years.

But Midmar supplies water to Mpopomeni and the cities of Pietermaritzburg and Durban. Shu and Mdu became Enviro-Champs and had been working with Liz Taylor of DUCT to detect blocked sewage lines and monitor the water quality.

After three and a half years of careful pollution monitoring very little had been achieved and there were still regular leaks and sewage flowing into the water that had to be purified for us to drink.It took all of these years of hard work for the problem in Midmar to be noticed and for their measurements and reports to be given attention. But in 2015 the Department of Water Services (DWS) began to send in teams to fix the leaks.

Mdu and Sbu had attended a training course on how to monitor water pollution and one of their assignments was to start a change project.

To start a change project, they became citizen scientists working with community members to detect leaks and to measure the quality of river water using the tools they had learned to use on the Wildlife and Environments Society of South Africa (WESSA) training course. They were also awarded a certificate for passing the course.

Solving problems and change was not an easy thing to do as they had to learn the science, teach it to others and then work as Enviro-Champ teams to help solve the sewage and other water problems that they detected.

On their course they learned about the Sustainable Development Goals and used these as a tool to identify all of the complex parts of the problem that the community would have to solve together.

They were proud of their analysis using the SDG Wheel (see diagram below) as a tool for finding out that the Midmar pollution problem was a deep issue that would require many challenges to be resolved.

Description of catchment

The streams from the Mpophomeni township flow under the main road and into Midmar Dam.

What we now know

The sewage problem has many complex elements that need careful measurement, careful thought and concerted action.

Scope of local concerns

Sewage flowing from the manholes into the wetland and streams are affected by, and effect, many of the SDGs (See stars)

Leading questions

Where are the sewage leaks?

What are the main causes?

What can we do together to solve them?

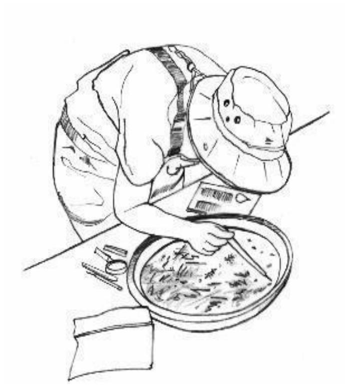
Did You Know?

What lived before the dinosaurs can tell us how clean our rivers and streams are.

It is surprising that wherever humans live on earth and we go down to a local stream we will find many similar organisms. Whether we live in the warm tropics or the colder temperate regions or in low-lying freshwater areas or up in the mountains.

Scientists have discovered that freshwater life (macro-invertebrates) lived before the time of the dinosaurs when there was one mega continent on earth. Then over the millennia, before life as we know it, the continents slowly drifted apart and now similar, locally adapted water organisms are scattered all over the world.

This means that any class in any school anywhere in the world can read and assess water quality using the organisms that live in their local stream.



Story 3: Polluted Rivers (Mexico)

During the 1980s, the Coatzacoalcos River, located in southern Veracruz, Mexico, was considered the most polluted river in the world. This, because Mexico was "lucky" to have a lot of oil in its subsoil and the government took on the task of extracting the oil in order to develop the country. For this, the extractive and transforming oil industry settled in this part of the country. Unfortunately, the arrival of the oil industry that dumped its industrial waste into the river and the little environmental legislation that existed at the time, caused the river to become very polluted, that people who depended on fishing lost their food sustenance, and that a species native to the country was on the verge of extinction: the manatee (Trichechus manatus).

Fortunately, many fishermen and citizens organized and demanded that the industry control their waste so that it did not reach the river. They took water samples, pictures of the pollution, etc., to demand that this change. After many years of organized citizen demand, the citizens managed to get the industry to stop dumping their waste into the river. Thanks to these people, today fishermen can once again get their food from the river and manatees can once again be seen swimming freely down the beautiful Coatzacoalcos River.

Story 4: Indicators of River's Health (India)

River Ganga is considered as one of the most sacred rivers of the world and is deeply revered by the people of India. It travels a 2,525 km long course from its origin at *Gomukh* in Himalaya to *Gangasagar* in Bay of Bengal. Due to the variation in altitude, climate, flora and fauna, land use and cropping pattern, the river has several unique features. Millions of people are dependent on the river for agriculture, irrigation, power generation, human and cattle consumption, fish production, tourism, pilgrimage and recreation.

It is also a lifeline for various species of animals and plants which thrive in and around river Ganga. The Ganges River dolphin found in Ganga is the only mammalian predator of the river ecosystem. Being on the apex of the food chain, species are indicators of good health of the river ecosystem. During the last few decades, the river and its biodiversity has been under severe danger where dolphins and several other species of turtles and crocodiles are listed as endangered. Instead of several efforts by the government, the water quality is deteriorating day by day which has limited the presence of dolphins only on a few stretches of the river.

In 2008, Ganga was declared a national river and dolphin as National aquatic animal to give focus on protection and conservation of river and its biodiversity. Centre for Environment Education (CEE) has been working along Ganga with schools and communities to build awareness and understanding but also to sensitize them towards adopting positive sustainable actions. To help school children to monitor river water quality, a simple kit 'Pani Parikshan' (Water Testing) was developed as an educational activity for schools. Several education and communication initiatives have been designed for schools including mobile exhibitions, campaigns, educational packages, action projects etc. Local NGOs, government departments and schools in Ganga town form a cluster and work towards sensitizing the community around.

News Update

COVID-19 - A Saviour for Rivers?

Nationwide lockdown in India seems to have improved the water quality of the mighty Ganga River. According the Centre Pollution Control Board (CPCB), out of the 36 monitoring units placed at various points in river Ganga, the quality of water in 27 points was identified as suitable for bathing and propagation of wildlife and fisheries. Despite numerous river clean programmes, the Ganga was running polluted. But a pandemic lockdown has been a ventilator for this river. Until the lockdown, it was thought that 80% of the waste entering the Ganga is the domestic sewage from nearby towns and villages and the rest was industrial waste.

During the lockdown, the domestic sewage might have increased due to increased water demand for hand-wash hygiene practices. Industries were not functioning during lockdown and hence industrial waste did not enter Ganga. Other activities like tourism, bathing, and washing clothes also was stopped. Through this expert identified that sewage was not the only concerning factor of Ganga. NO pollution from industries helped Ganga. Increased rainfall this year due to western disturbances improved the flow in the river leading to dilution. However, as the world has slowly started functioning and getting back to normal, there are higher possibilities of the river getting more polluted than usual due to increasing economic demand. Do we want such positive changes to happen only when a global pandemic hits us? Or can we as individuals, as institutions, as government bodies and as a whole world reconsider our lifestyles, economic and developmental pursuits so that the planet is less damaged?

Source: COVID-19 lockdown: A ventilator for rivers. Published on 29th April 2020. Down to Earth

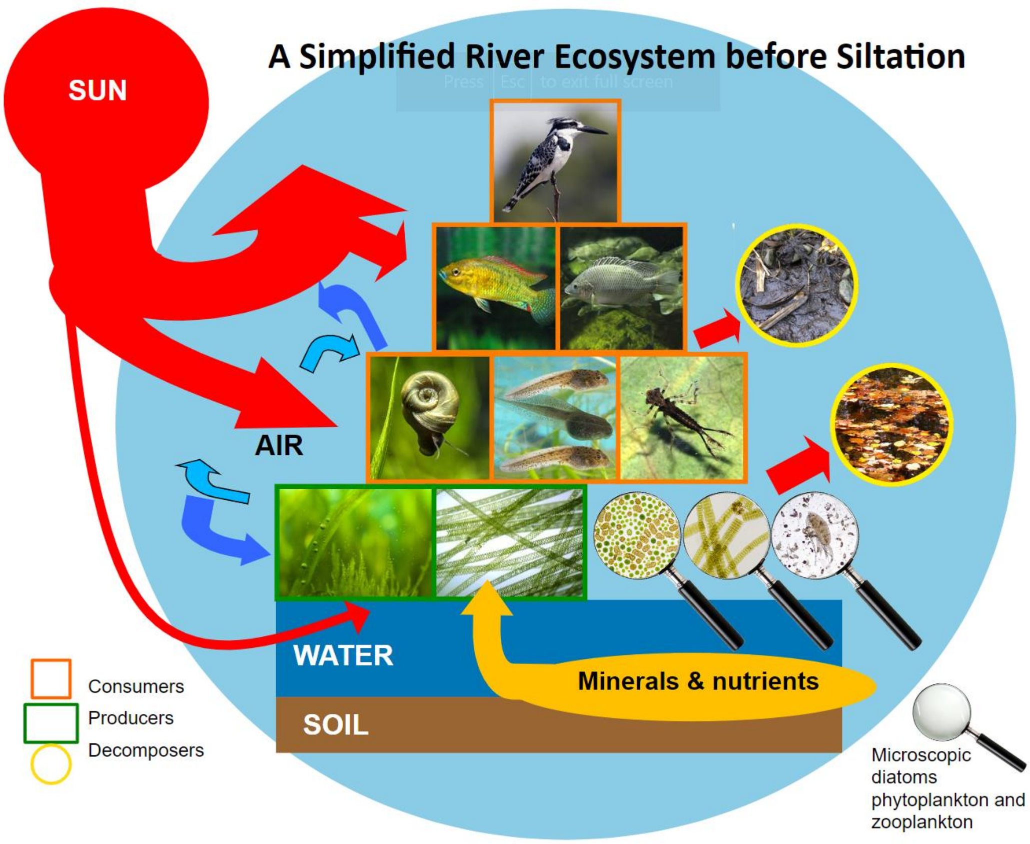
Quadrant 2
Inquiry & Deepening Knowledge

Eco Puzzle Activity 1: **Puzzling Water Quality**

Mdu and Sbu showed the class an Eco-Puzzle to model how detritus, algae, phytoplankton and zooplankton are the food for the water organisms and, in turn, food for a kingfisher. The simplified model was then used to model the impact of soil erosion and sewage leaks.

The creative animation that follows will show us how erosion can make the water cloudy (turbid) and how this affects water life.

Leading Question
How do sewage and erosion affect river life?



Bleeding Soil

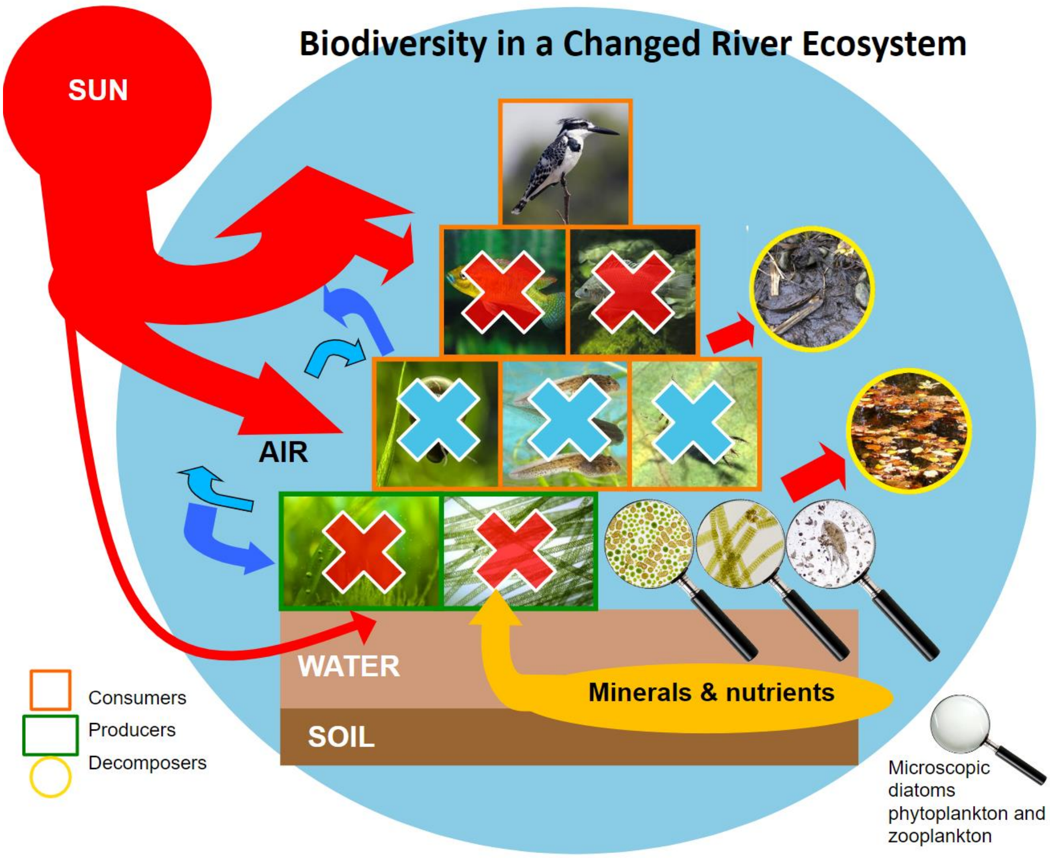
Soil erosion causes silt in the river which blocks the light from getting through the water.

This causes the water temperature to change, which is not good for species that need stable temperatures to survive.

It also causes problems for hunters like the kingfisher who are not able to see the fish below the water surface, or predatory fish who cannot see their food.

It also makes it darker under the surface of the water which means the plants in the water do not have enough sunlight to photosynthesis. Plants will die because they cannot make enough food to survive.

Less plants means less oxygen in the water that all other species rely on to survive.



Quadrant 3
Review, Analysis & Critical Thinking

Did you know?
Citizen scientists are assessing river catchments

Eco Puzzle activity 2: **Work Out Water Quality**

Divide the class into several groups. Let the students collect water from different water sources. All the samples could be collected on the same day. Each sample should be accompanied by a brief description of the source from which it was taken.

Now ask each group of students to carry out the experiments with each sample of water and to note down their observations and results. Students should record their observations in the common table given below:

Source	Odour	Colour	Turbidity	Solid Particles present	Dissolved Particles present	Acidic/ alkaline/ neutral	Dissolved air present	Hard or soft water

Discussion
Ask them why water from some sources may not be suitable for human consumption? Water that looks clean may contain microorganisms (that can cause diseases like cholera, typhoid and jaundice), heavy metals, etc. and need to be treated further to make it suitable for drinking.

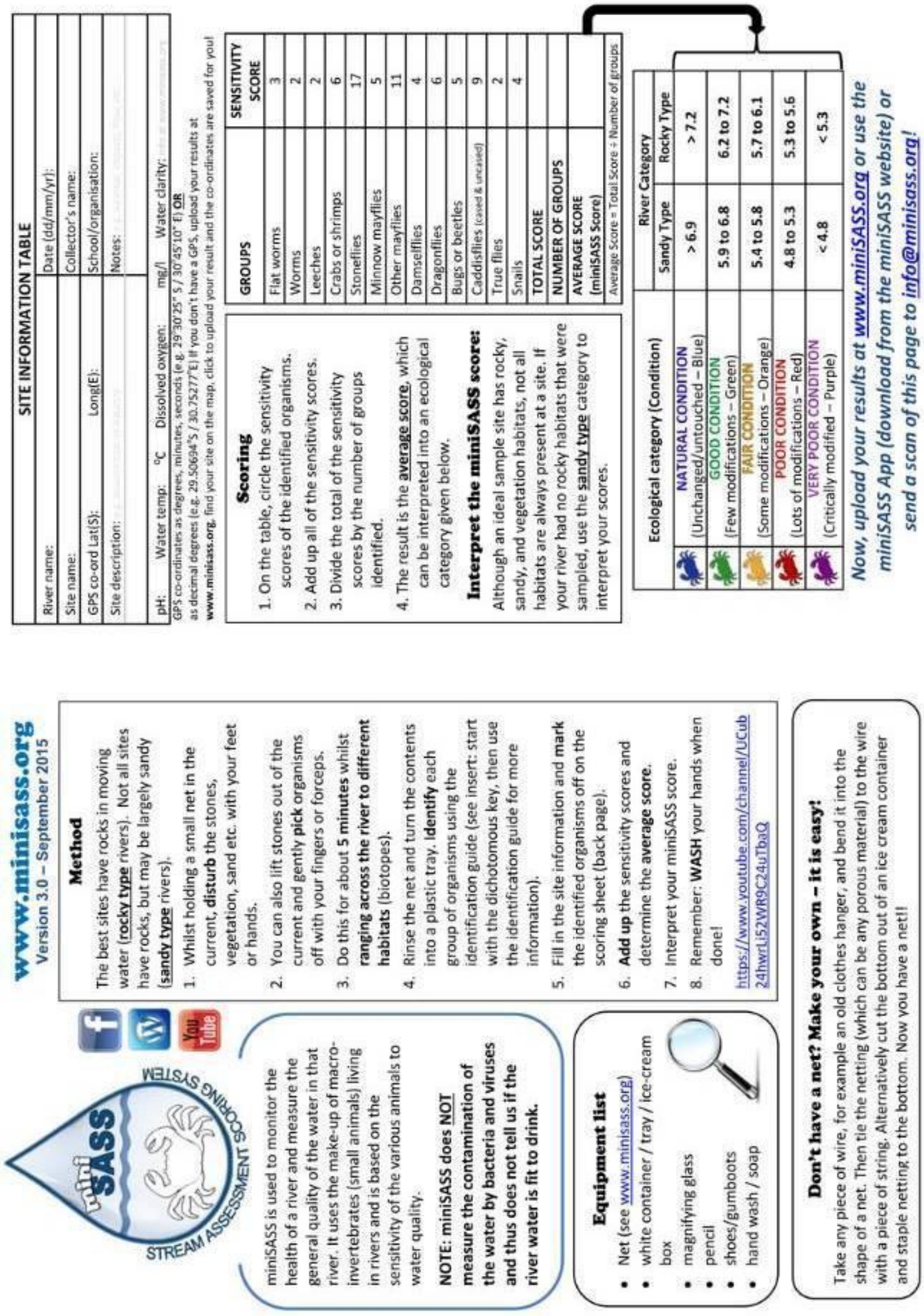
Let the students compare their observations and results obtained from the experiments with various samples of water. Based on this, ask the students to differentiate between the different types of water collected from various sources.

Now ask the students to briefly describe the quality of the water from the various sources and the possible uses of each quality of water.

Source: Paryavaran Mitra. Teacher's Handbook (2011). Centre for Environment Education. CEE. Page 43-45.

Eco Puzzle activity 3: **Assess a local river using the MiniSASS tool**.

See below diagram about the tool.



www.minisass.org
Version 3.0 – September 2015

miniSASS is used to monitor the health of a river and measure the general quality of the water in that river. It uses the make-up of macro-invertebrates (small animals) living in rivers and is based on the sensitivity of the various animals to water quality.

NOTE: miniSASS does NOT measure the contamination of the water by bacteria and viruses and thus does not tell us if the river water is fit to drink.

Equipment list

- Net (see www.minisass.org)
- white container / tray / ice-cream box
- magnifying glass
- pencil
- shoes/gumboots
- hand wash / soap

Method

The best sites have rocks in moving water (**rocky type** rivers). Not all sites have rocks, but may be largely sandy (**sandy type** rivers).

1. Whilst holding a small net in the current, **disturb** the stones, vegetation, sand etc. with your feet or hands.
2. You can also lift stones out of the current and gently **pick** organisms off with your fingers or forceps.
3. Do this for about **5 minutes** whilst **ranging across the river to different habitats** (biotopes).
4. Rinse the net and turn the contents into a plastic tray. **Identify** each group of organisms using the identification guide (see insert: start with the dichotomous key, then use the identification guide for more information).
5. Fill in the site information and **mark** the identified organisms off on the scoring sheet (back page).
6. **Add up** the sensitivity scores and determine the **average score**.
7. Interpret your miniSASS score.
8. Remember: **WASH** your hands when done!

https://www.youtube.com/channel/UCub24hwrLi52WR9C24uTbaQ

Don't have a net? Make your own – it is easy!

Take any piece of wire, for example an old clothes hanger, and bend it into the shape of a net. Then tie the netting (which can be any porous material) to the wire with a piece of string. Alternatively cut the bottom out of an ice cream container and staple netting to the bottom. Now you have a net!!

SITE INFORMATION TABLE	
River name:	Date (dd/mm/yr):
Site name:	Collector's name:
GPS co-ord Lat(S): Long(E):	School/organisation:
Site description:	Notes:
pH: Water temp: °C Dissolved oxygen: mg/l Water clarity:	

GPS co-ordinates as degrees, minutes, seconds (e.g. 29°30'25" S / 30°45'10" E) **OR** as decimal degrees (e.g. 29.50694°S / 30.75277°E) If you don't have a GPS, upload your results at **www.minisass.org**, find your site on the map, click to upload your result and the co-ordinates are saved for you!

Scoring

1. On the table, circle the sensitivity scores of the identified organisms.
2. Add up all of the sensitivity scores.
3. Divide the total of the sensitivity scores by the number of groups identified.
4. The result is the **average score**, which can be interpreted into an ecological category given below.

Interpret the miniSASS score:

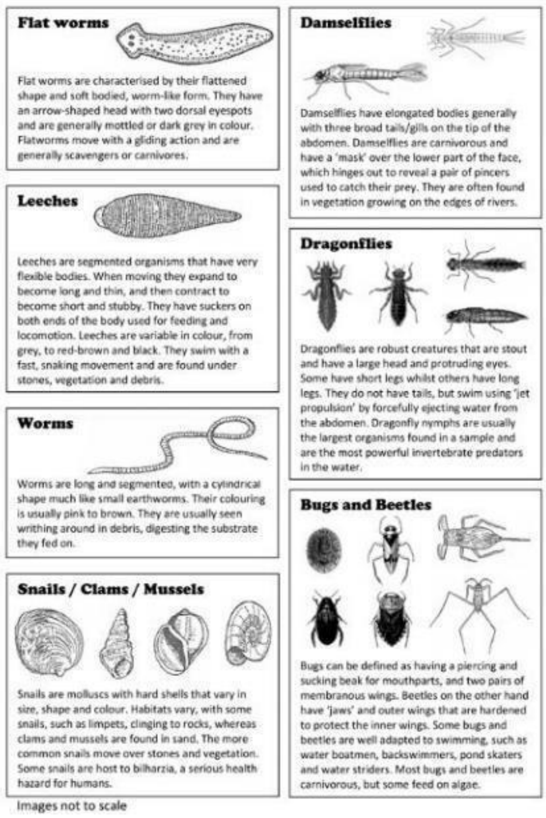
Although an ideal sample site has rocky, sandy, and vegetation habitats, not all habitats are always present at a site. If your river had no rocky habitats that were sampled, use the **sandy type** category to interpret your scores.

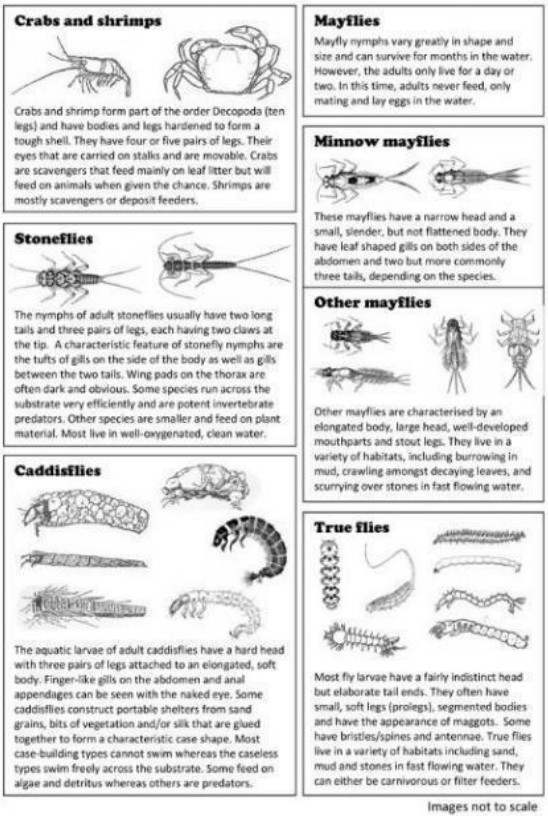
GROUPS	SENSITIVITY SCORE
Flat worms	3
Worms	2
Leeches	2
Crabs or shrimps	6
Stoneflies	17
Minnow mayflies	5
Other mayflies	11
Damselflies	4
Dragonflies	6
Bugs or beetles	5
Caddisflies (cased & uncased)	9
True flies	2
Snails	4
TOTAL SCORE	
NUMBER OF GROUPS	
AVERAGE SCORE (miniSASS Score)	

Average Score = Total Score ÷ Number of groups

Ecological category (Condition)	River Category: Sandy Type	River Category: Rocky Type
NATURAL CONDITION (Unchanged/untouched – Blue)	> 6.9	> 7.2
GOOD CONDITION (Few modifications – Green)	5.9 to 6.8	6.2 to 7.2
FAIR CONDITION (Some modifications – Orange)	5.4 to 5.8	5.7 to 6.1
POOR CONDITION (Lots of modifications – Red)	4.8 to 5.3	5.3 to 5.6
VERY POOR CONDITION (Critically modified – Purple)	< 4.8	< 5.3

Now, upload your results at www.miniSASS.org or use the miniSASS App (download from the miniSASS website) or send a scan of this page to info@minisass.org!





Assess water life in a local stream

The *Kamishibai* picture sequence maps out how to situate and use MiniSASS tools to assess the health in a local river or stream. See part III on picture stories for discussion in classroom.

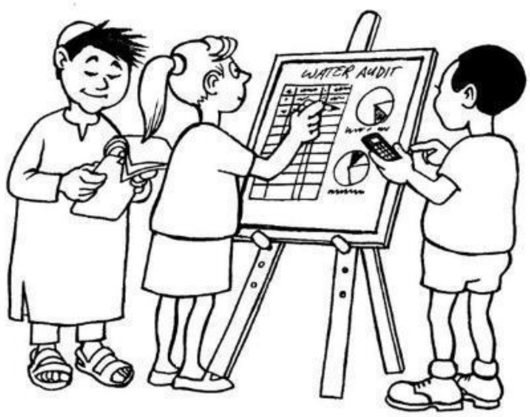
Quadrant 4
Handprint Actions for Change

What goes down the drain has to end up somewhere….

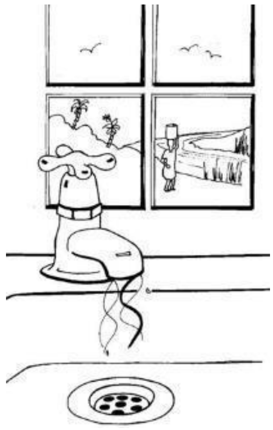
Record what goes down a household drain.
Assess what goes down the drain over a week.

Describe:

1. What oils and toxins are in the waste water.
2. What organic matter and solid waste are disposed of.
3. What nutrients (phosphates, nitrogen) will the drain water add to the system.



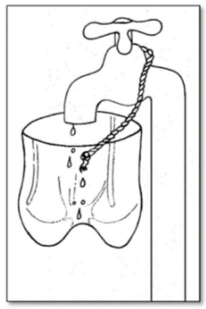
Assess a dripping tap



Work out the volume of water in one minute.

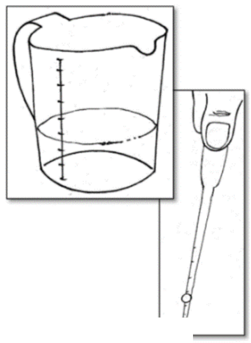
Calculate the water wasted each day (24 hours).

- For a slow leak, collect the drips in a small container for a minute. Use a calibrated propette to calculate millilitres of wasted water collected.
- For fast leaks and running taps, use a bucket to collect the water.
- Use a measuring jug to measure the amount of water lost per minute.
- Find out the cost of water and calculate the savings if 10 dripping taps are repaired per 5 day working week for a month.



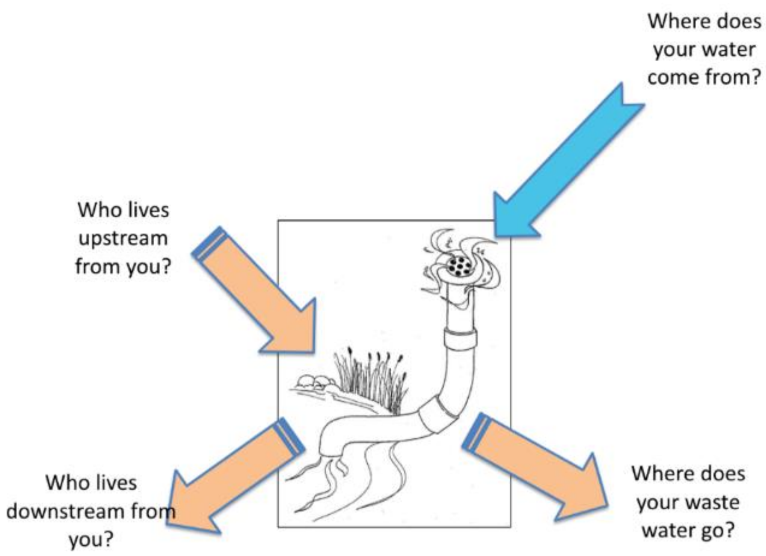
Calculate:

.............................ml x 60 = ... ml hour
(............................ml x 60) 24 = ... litres per day.



Somebody always lives downstream

Draw a mind map of:



How do we best live and work together in a changing world?

Eco-Puzzle Cards - Print and cut out the cards to model patterns of interdependence