River RANGER 2.0

a GEC environmental education programme

RIVER CARE
Action Guidebook

Founded by

Global Environment Centre

Introduction

The RIVER Ranger programme was initiated by Global Environment Centre in 2004. RIVER Ranger is a comprehensive program on water resource management, which focuses on rivers and river basin management. It also emphasizes not only about water pollution but every aspect of freshwater ecosystems including the functions, values, biodiversity and benefits to mankind.

With new features and scope for improvement identified along the 15 years, the RIVER Ranger programme is being upgraded to RIVER Ranger 2.0 (RR 2.0). RR 2.0 will have more aspects that will help to harness knowledge on integrated river basin management (IRBM) in a more practical manner.

Objectives

- To increase awareness and knowledge in managing water resources
- To provide living skills for use in local environment management
- To promote ways to evaluate their river basins
- To initiate localized water / river-based action / initiation
- To develop a database on local rivers' condition

RIVER Rangers 2.0 will undertake the following activities:

- **Be 'eyes' and 'ears' of the river by practicing 4R2P approach**
  4R2P approach covers both problem identification and mitigation measures. The approach enables the RIVER Ranger 2.0 to know the river address, do river mapping, carry out river hydrology and river monitoring to identify the problems. Pollution reduction and being proactive are the part of mitigation measures encouraged under this approach.
- **Be part of data sharing mechanism for bigger impacts**
  Data is to be uploaded and shared in the www.riverranger.my website to be shared by all parties who are involved in river basin management. Data sharing is important as it can be used for both preservation and conservation of that particular river stretch / streams by interested parties.

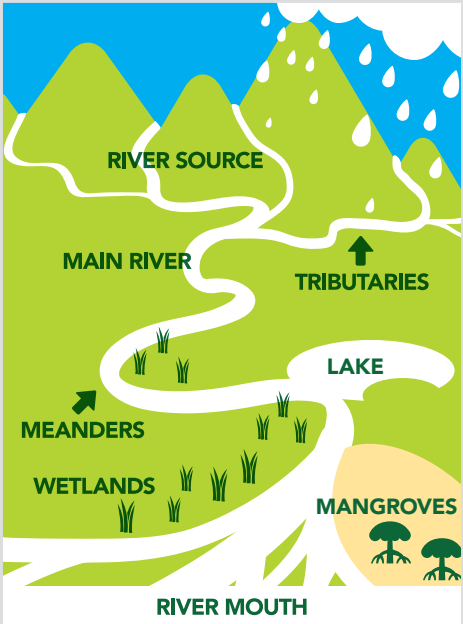
All about rivers

What is a river and a river basin?

A river is a natural waterway, which channels freshwater from the mountains to the sea. A river basin is the entire area drained by a river including its tributaries. That means, all water in the river basin area drains into the river and its tributaries. Therefore, the flow of water sets the boundaries of a river basin. They are also synonymously known as catchments or watersheds.

Rivers mostly begin as small trickles of water up in the mountains. This is its source, and it eventually forms a small stream which then flows down the mountain. The water erodes the land, carving a bigger channel and forms the main river.

Upstream areas are characterized by steep V-shaped valleys, waterfalls, and fast flowing water among boulders and rocks. In the middle part, the river winds its way slowly through the flatter land, and continues to widen its channel by meandering and depositing material that is too heavy to carry in the water. As it makes its way out to the sea, it flows even more slowly and starts to deposit even more material in and around its own channel. At its mouth, where the river meets the sea, there is a sudden drop in velocity, and all the material that was being carried in the water column is deposited right there. As the material builds up from continuous deposition, the mouth of the river gets blocked and the river has to find new outlets into the sea by carving new streams wherever it can. This is the formation process of a delta and is characteristic of all river mouth areas.



Journey of a river

Impact
of daily activities

We all live in a river basin. Therefore, everything we do will somehow affect the land and waterways. When we drop a piece of rubbish, is someone going to pick up for us? NO. It gets blown away or washed away into our drains and into our rivers.

DRAINS are meant for rainwater ONLY. However, we find people, restaurants, factories and residential areas using them for disposal. All the waste that is discharged into these drains flow directly into the river without any treatment at all.

So the next time you eat at a restaurant, look into the closest drain. What do you see? The next time you pass a construction site or walk down a street filled with litter, imagine what happens when it rains?

We must realize the impact of all the 'small' things we do affects the environment and leads to BIG problems. So think about where all your rubbish and wastewater is ending up and do something about it!

Being a RIVER Ranger 2.0

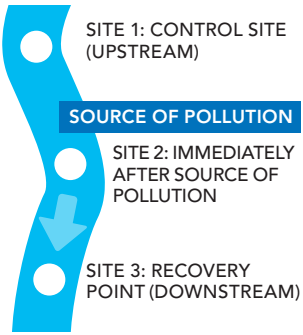
Carry out a survey like a real scientist! Make a plan for river monitoring!

Survey design

When river pollution is suspected happening from a point source, then you should have 3 sampling sites (see diagram).

The river changes from the headwaters to the mouth. That is why sampling sites should be dispersed along the length of the river so that changes in water quality can be noted.

To conduct a local water quality monitoring programme, sampling sites should cover areas before, within and immediately after the subcatchment area or pollution source.



Where to sample

It is important to exercise care in the way samples are collected for analysis. A collected sample should be representative of the river reach being tested. Analytical values derived from river samples may vary with depth, velocity of current and the distance the sample was taken from source/shore. Samples taken are called grab samples, which are single samples representative of the river at a particular time and place.

When choosing a monitoring site, please:

- Confirm the site is located within the watershed. Determine if the site is located on public or private property (in which case you require permission before visiting the site to conduct water quality monitoring and watershed research).
- Check for any habitats or shelters where animals may be living such as snake holes etc., near the monitoring site.
- Identify a monitoring site that is at a safe distance from any nearby roads or traffic.
- Avoid deep water or fast currents unless standing on a bridge. Locate a riffle (shallow water) area instead which would likely support a greater abundance of aquatic life.
- Avoid steep, eroding shorelines by identifying a site with accessible banks.
- Be aware of nearby structures (sewage treatment plants) or heavy industrial areas which may require special protection gears for the arms and hands when conducting a survey.

Safety precaution

- Ensure that everyone understands the danger of treating chemicals casually or endangering others during "horseplay."
- Wear safety goggles, especially when conducting water quality tests that require shaking or swirling a chemical mixture.
- Avoid placing hands in contact with eyes or mouth during monitoring.
  Always wash hands after conducting water monitoring.
- Dispose of spent chemicals in an environmentally sound manner; hazardous waste should be deposited in accordance with the hazardous waste guidelines.

The best place to collect a sample is midway across the river (within the main current) and below the surface.

ONLY DO THIS WHEN IT IS SAFE TO DO SO.

River studies

The scientific study of rivers are an important aspect in its conservation. We will be motivated to act when we have acquired the information and knowledge we gather from doing river studies. There are many different studies you can do, and they are outlined here.

Ecology

A river is not merely a channel for water to flow. There are living things that depend on the river for survival, both in the water and on the land the river supports. The narrow area along a river is called the riparian corridor. This area supports a variety of plants and trees that contribute nutrients, shade, soil stability, habitat, and organic materials for small organisms to eat. Rivers contain living things such as aquatic plants, fish, crustaceans, and mollusks, and also supports insects, birds and mammals which utilize the river for many purposes. As such, rivers provide a great variety of habitats and services for all living things and it is important to maintain both physical and biological diversity in and around rivers.

It is important to recognize rivers as a living entity. Without the living things that live around and within it, rivers cannot function as nature intended. Therefore, it is important to care for our rivers and ensure that the quality of our rivers remain in a pristine state.

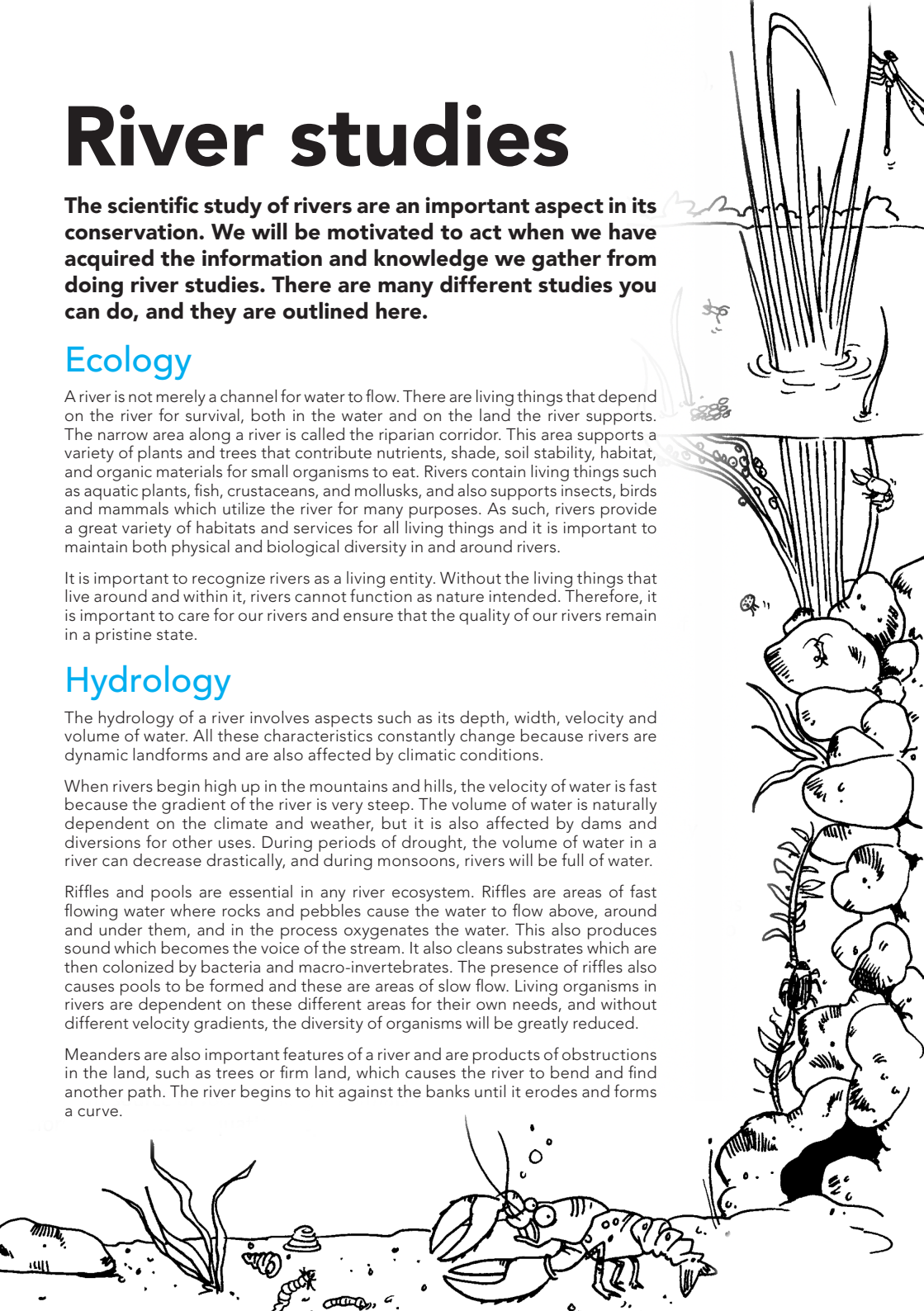
Hydrology

The hydrology of a river involves aspects such as its depth, width, velocity and volume of water. All these characteristics constantly change because rivers are dynamic landforms and are also affected by climatic conditions.

When rivers begin high up in the mountains and hills, the velocity of water is fast because the gradient of the river is very steep. The volume of water is naturally dependent on the climate and weather, but it is also affected by dams and diversions for other uses. During periods of drought, the volume of water in a river can decrease drastically, and during monsoons, rivers will be full of water.

Riffles and pools are essential in any river ecosystem. Riffles are areas of fast flowing water where rocks and pebbles cause the water to flow above, around and under them, and in the process oxygenates the water. This also produces sound which becomes the voice of the stream. It also cleans substrates which are then colonized by bacteria and macro-invertebrates. The presence of riffles also causes pools to be formed and these are areas of slow flow. Living organisms in rivers are dependent on these different areas for their own needs, and without different velocity gradients, the diversity of organisms will be greatly reduced.

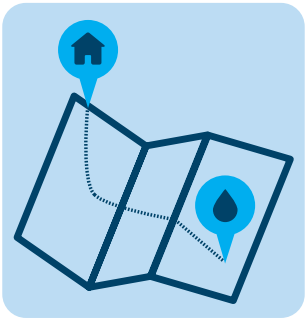
Meanders are also important features of a river and are products of obstructions in the land, such as trees or firm land, which causes the river to bend and find another path. The river begins to hit against the banks until it erodes and forms a curve.



What RIVER Ranger 2.0 covers?

4R2P approach

River
Address



River
Mapping

River
Hydrology

River
Monitoring

Pollution
Reduction

Proactive

River address

River address is a simple yet meaningful exercise developed by Global Environment Centre (GEC) to get the public or stakeholders to know more about their respective river basin. By knowing the river address, we can start initiate action at local level and protect our river basin. By identifying our own river basin, we will start to love drains which directly feeds the river. Drains are only meant for channeling rainwater, but our irresponsible actions making drains are polluted before the river. If the feeding inlet to the river is polluted, how we can improve water quality of rivers? We can initiate drain clean-up activities, as cleaning drains not only helps to clear the pollutant loadings into river, but also reduces risk of diseases such as dengue. Besides this, river cleaning and adoption activities can be initiated with involvement of key stakeholders most importantly youths and children, who will own the river basin after us.

DO YOU KNOW WHERE IS YOUR RIVER BASIN?

Locate your house in a map of your area. Find the drain located within your housing area.

Can you identify the nearest river? **List down the name**.

Does the river leads into a 2nd river? **List down the name**.

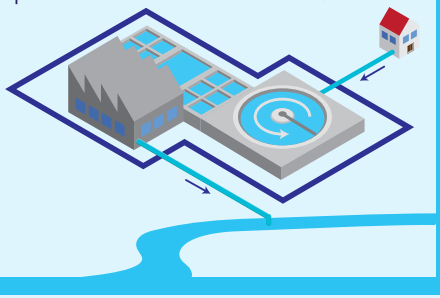
Follow the river flow until it reaches the sea. **List down any connecting rivers on the way**.

DO YOU KNOW WHERE YOUR DRINKING / TAP WATER COMES FROM?

Find the nearest water treatment plant. **List down the location / name.**

FIND OUT WHERE YOUR WASTEWATER GOES TO

Find the nearest wastewater treatment plant. **List down the location / name.**



River mapping

Rivers, streams, and lakes are more than just parts of the environment - they are living entities that provide homes for wildlife and sustain life in this world. In Malaysia, rivers provide 97% of our water supply, and are used as places of recreation and enjoyment.

There must be a balance when we are using such fragile ecosystems for other purposes, as minor disturbances may cause problems within the system and may be detrimental to the environment. This is because each river does not work alone. They are all part of a bigger network called a river basin. All water will eventually flow into the waterways contained in this river basin area. Therefore, anything that happens within the basin will affect the rest of the basin because they are all connected.

River Mapping encourages RIVER Rangers 2.0 to:

- Learn about their local environment
- Develop skills in investigating the local environment
- Acquire a concern for the environment

Through investigations of River Mapping, RIVER Rangers 2.0 will collect information which may identify a problem or issue in their local area. For example, after identifying that a local stream is heavily littered, RIVER Rangers 2.0 will need to ask a number of questions, such as:

- Where did the litter come from?
- What can be done about this?
- Who should I inform?

Structure of River Mapping

River Mapping makes use of your natural senses, such as sight and smell to identify the physical attributes of the river and its surroundings. The first step is to map out your local area and the location of the river within this area (use back page). Once you have done this, you can add in all the different types of land use you see in the area and activities that may affect the river.

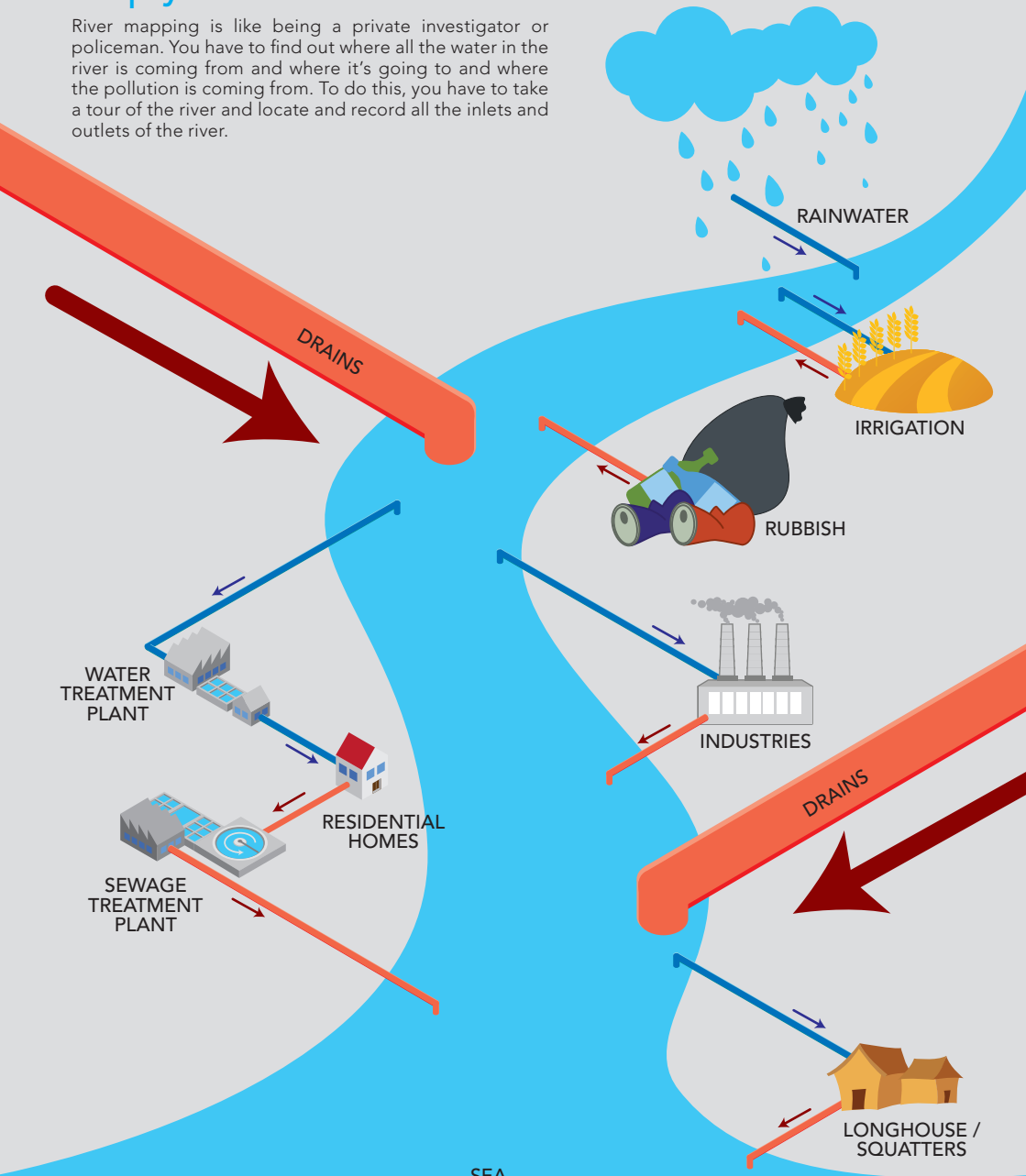
Next, you should go to the river itself, and record its appearance. What colour is the water? Is there any oily sheen on its surface? Think about what could be causing this and refer to the table on the last page for help. Other things you should note is the type of vegetation found near the river, and how much there is, as well as whether there is any smell coming from the river.

Through the River Mapping programme, RIVER Rangers 2.0 will learn how the action they take in their home, school or street can impact on their wider environment. By testing the quality of water in their local area, RIVER Rangers 2.0 will be encouraged to investigate their environment and actively participate in improving the quality of their environment. The River Mapping activities will also encourage an interest in other environmental issues. These may include:

- The interaction between natural and developed environments
- Waste disposal and recycling
- Sustainable resource management

Map your river inlets and outlets

River mapping is like being a private investigator or policeman. You have to find out where all the water in the river is coming from and where it's going to and where the pollution is coming from. To do this, you have to take a tour of the river and locate and record all the inlets and outlets of the river.



River hydrology

Good hydrology is important for the health of our rivers and quality of our water. This includes aspects such as depth, width, velocity and volume of water (discharge). There should be different varieties of all these in a river to maintain its natural flow.

Velocity

The velocity of a river is the speed at which water flows along it (distance/time). The velocity will change along the course of any river, and is determined by factors such as the gradient (how steeply the river is losing height), the volume of water, the shape of the river channel and the amount of friction created by the bed, rocks and plants.

Equipment

- Orange or a ping pong ball
- Stopwatch
- Measuring tape
- 3 people

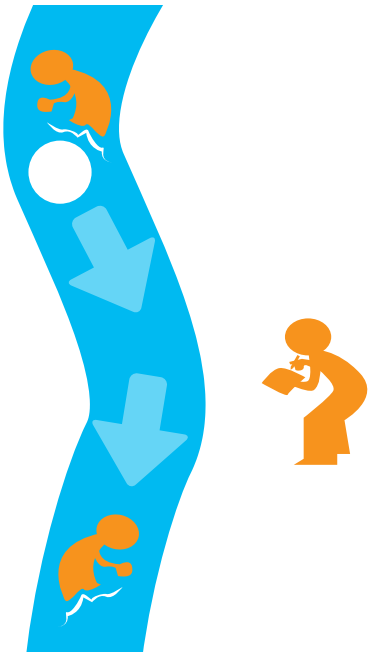
Measuring velocity

It's very easy to measure the velocity of the water in an area.

- Find a good stretch of the river and make sure the river
  - is shallow; and
  - safe enough to walk into.

You will need 3 people to do this.

- The 1st person upstream with the orange and 2nd person downstream to catch the orange.
- The 3rd person will be on land and has to measure out a distance of 10m (this can change according to what you want to measure) and take note of the time it takes for the orange to flow over the 10m.



Tips

- Place the orange in the middle of the water flow to gain the most accurate readings aswater flow near the banks is usually slower.
- Do this test at least 3 times to get an average reading.

EXAMPLE:
Measure timing four times over a distance of 10m.

RESULTS:
1st: 36 seconds, 2nd: 28 seconds, 3rd: 34 seconds, 4th: 30 seconds

Calculate average time

$$\frac{36 + 28 + 34 + 30}{4} = 32\,\text{sec}$$

Calculating velocity

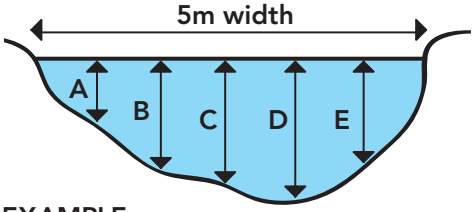
$$\frac{\text{DISTANCE}}{\text{AVERAGE TIME}} = \text{AVERAGE VELOCITY}$$

$$\frac{10}{32} = 0.3125\text{m/sec}$$

The surface velocity is found to be 0.3125 metre per second.

Discharge

The river's discharge at that location depends on the rainfall on the catchment or drainage area and the inflow or outflow of groundwater to or from the area, stream modifications such as dams and irrigation diversions, as well as evaporation and evapotranspiration from the area's land and plant surfaces. The discharge of a river is useful to find out if there is enough water for a business or industry. It can also help you to predict flood extent downstream using data on flood waters upstream from you.



EXAMPLE:
A = 0.2m; B = 0.5m; C = 0.7m; D = 1m; E = 0.6m

Calculate average depth

$$\frac{A+B+C+D+E}{5}$$

$$= \frac{0.2+0.5+0.7+1+0.6}{5} = 0.6\text{m}$$

Please note

Discharge rate may increase or decrease over time as a result of changes in the river's velocity.

Calculating discharge rate

by the amount of water flowing past a point in a given unit of time to what you want to measure) and take note of the time it takes for the orange to flow over the 10m.

DISCHARGE RATE

$$= (\textit{RIVER WIDTH} \times \textit{AVERAGE DEPTH}) \times \text{AVERAGE VELOCITY}$$

$$= (5 \times 0.6) \times (0.3125)$$

$$= 0.9375\text{m}^3\text{/sec}$$

The river's discharge rate is found to be 0.9375 cubic metre per second.

RR 2.0 DATASHEET*

**Developed based on GEC's 15 years' experience on community based water quality monitoring.*

Name:

Contact Number:

Email:

School/Organization:

Number of People:

Date/Time: *(data collection)*

State:

Location (site area):

River's Name:

Section: Upstream Midstream Downstream

River Basin's Name:

Weather: *(Cloudy, sunny, etc.)*

Has it rained in the past 24 hours? Was it heavy?

River Address

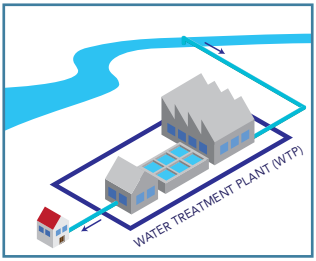
Do you know your River Basin?

Using a map, locate the drain or river nearby. Identify the flow of the water into the nearest river to the sea.

ANSWER

Do you know where your drinking /tap water comes from?

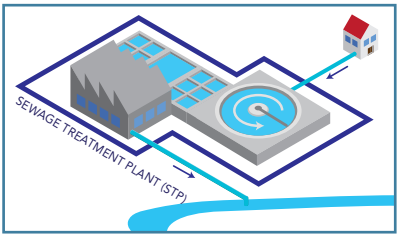
Knowing where your local water supplies will help you to know any possible threats water supplies face and steps that you could undertake to protect your water supplies. Also know what your community is doing to protect your water supply. Help others to be aware on the importance of clean water in your community.



ANSWER

Find out where your wastewater goes to

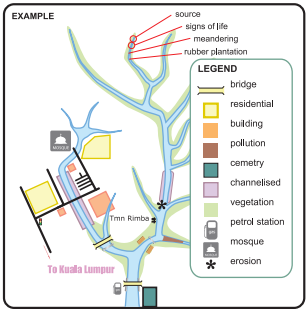
Wastewater treatment removes the suspended solid from the wastewater before it can be discharged to the river safely. Identify your wastewater treatment plant nearby your area and get to know which river the discharge goes to.



ANSWER

River Map

Draw your area map here and record the land use. Create a legend to identify the different types of land use and other points of interest.



River Hydrology

DISTANCE (A):			
T1	T2	T3	AVERAGE TIME (B)
AVERAGE VELOCITY (C)	= A ÷ B =		

W 1	W 2	W 3	AVERAGE RIVER WIDTH (D)

D1	D2	D3	AVERAGE RIVER DEPTH (E)

DISCHARGE RATE
= (*RIVER WIDTH*
x AVERAGE DEPTH)
x AVERAGE VELOCITY

= (D x E) x C

= DISCHARGE RATE

Physical Monitoring* (PM)

**Developed based on GEC's 15 years' experience on community based water quality monitoring.*

Observe, identify and score based on the 9 categories below:

Category 1: Voice of the stream

0-2 No natural voice , Stagnant water

3-5 Some sound of nature (including animals), Slow moving water

6-8 Sound of nature especially water, Good flowing water

9-10 Sound of water (bubbling etc.), Natural flow

C1 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 8-10

Category 2: Land use

0-2 Urbanized city centre, fully developed

3-5 Industrial, agriculture, wetmarket, workshop, food court area, commercial

6-8 Residential, recreational area and minimal commercial

9-10 Very minimal human activities, forest reserve, protected catchment

C2 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 3: Rubbish

0-2 Fully covered with floatable rubbish (plastics, bottles, cans, food packaging)

3-5 Significant amount of human made rubbish,

6-8 Mixture of man made waste and organic waste (leaves, twigs and branches)

9-10 Natural leaves and twigs, insignificant floatables

C3 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 4: Pipes & drains

0-2 Direct effluent disharge pipes from the industries, wetmarket, foodcourts, STP and other form of pollution

3-5 Discharge from treated pipes into the stream, sullage water discharge

6-8 Urban storm water, drainage system

9-10 No pipes or drains

C4 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 5: Structures /modifications

0-2 More than 3 structures / modifications that have negative impact on water flow or quality.

3-5 1 or 2 structures / modifications that have negative impact on water flow or quality.

6-8 Structures / modifications that have good impact on water flow or quality.

9-10 No structure / modifications (natural flow conditions)

C5 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 6: Smell

0-2 Very strong unnatural smell (Sewage, Chemical etc.)

3-5 Strong unnatural smell (Sewage, Chemical etc.)

6-8 Slight unnatural smell (Sewage, Chemical etc.)

9-10 No smell, Natural Smell.

C6 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 7: Water conditions

Please take note the discharge points (point source & non-point source) to the river that causes the change in conditions

0-2 Turbid, muddy or silted which is brownish in colour, greenish or milky (indicate the colour is due to pollution)

3-5 Greenish/blackish colour with scum and floatable particles, oily sheen, foamy

6-8 Green floatable vegetation,algae

9-10 Colourless

C7 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 8: Vegetation

Look at the river and banks and check if the wetland plants are introduced or natural. Check whether erosion occurs or not.

0-2 Erosion or land clearing,

3-5 Modified river bank landscape with introduced species.

6-8 Modified river bank landscape with local species and some wetland plants within river.

9-10 Mainly natural vegetation on river bank and wetland plants within river.

C8 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

Category 9: Vertebrate animal life

(birds*, reptiles, fish, amphibians & mammals)

** Using bird books, learn the names of the birds found around the site and compile a list.*

0-2 NO animal life visible at all.

3-5 At least two types of animal life.

6-8 At least three types of animal life.

9-10 More than three types of animal life found.

C9 SCORE	WITHIN BEST SCORE (Y/N)

Best score: 9-10

NO. OF YES (BEST SCORE)

Calculating physical monitoring index

NO. OF YES (BEST SCORE)	PM INDEX	WATER QUALITY	MOUTH GUIDE SCORE
9	5	Excellent	
7 to 8	4	Good	
4 to 6	3	Average	
2 to 3	2	Poor	
0 to 1	1	Very poor	

PM INDEX

Chemical Monitoring (CM)

Record your results from the Water Quality Test Kit here.

PARAMETER	SITE 1	BEST SCORE	WITHIN BEST SCORE (Y/N)	NO. OF YES (BEST SCORE)
pH		*6-8*		
Dissolved Oxygen (ppm)		4 / 8		
Phosphate (ppm)		*1*		
Nitrate (ppm)		*5*		
Turbidity (JTU)		0		
Temperature (°C)		*N/A**	*N/A**	

**Not applicable as its optimal temperature varies.*

Calculating chemical monitoring index

NO. OF YES (BEST SCORE)	CM INDEX	WATER QUALITY	MOUTH GUIDE SCORE
6	5	Excellent	
5	4	Good	
3 to 4	3	Average	
2	2	Poor	
0 to 1	1	Very poor	

CM INDEX

Biological Monitoring (BM): BWQI

Identify and record the organisms found here. Refer **page 25** for the score.

	SPECIES (A)	SCORE	TOTAL SCORE (B)	BWQI (B ÷ A)
SITE 1				

Calculating biological monitoring index (BWQI)

BWQI RANGE	BM INDEX	WATER QUALITY	MOUTH GUIDE SCORE
7.6-10	5	Very clean water	
5.1-7.5	4	Clean water	
2.6-5.0	3	Average	
1.0-2.5	2	Dirty water	
0-0.9	1	Very dirty water	

BM INDEX

River Ranger Index* (RRI)

**Developed based on GEC's 15 years' experience on community based water quality monitoring.*

Calculate the river's health by using River Ranger Index

CATEGORY	INDEX (A)	WEIGHT (B)	SUB-CATEGORICAL INDEX ((A/5) X B)
PHYSICAL (C)		1.75	
CHEMICAL (D)		1.25	
BIOLOGICAL (E)		2	
RIVER RANGER INDEX (C + D + E)			

RIVER RANGER INDEX (RRI)	CLASS*	RIVER STATUS	MOUTH GUIDE SCORE
4.55 - 5.00	A	Very good	
3.55 - 4.54	B	Good	
2.55 - 3.54	C	Moderate	
1.55 - 2.54	D	Poor	
1.00 - 1.54	E	Critical	

**this is different from DOE Malaysia river classes*

Your River Health is

RIVER RANGER INDEX (RRI)	CLASS	RIVER STATUS	MOUTH GUIDE SCORE
			

River monitoring

River monitoring can be done using three (3) methods. They are **Physical monitoring**, **Chemical monitoring** and **Biological monitoring.** Each of them will give you a index to calculate the River Ranger Index (RRI) which represents the health of a stream / river.

Physical monitoring

uses your senses to observe and test the physical characteristics of a river as a guide to indicate the river's health.

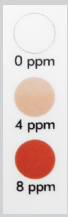
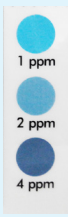
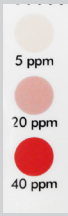
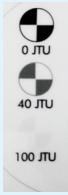
APPEARANCE	INDICATES	POSSIBLE CAUSES
Green, Green-Blue, Brown or Red	Growth of algae	High levels of nutrient pollution, originating from organic wastes, fertilizers, or untreated sewage.
Muddy, Cloudy	Elevated levels of suspended sediments, giving the water a muddy or cloudy appearance.	Erosion is the most common source of high levels of suspended solids in water. Land uses that cause soil erosion include mining, farming, construction and unpaved roads.
Dark Reds, Purple, Blues, Blacks	May indicate organic dye pollution.	Originating from clothing manufacturers or textile mills.
Orange-Red	May indicate the presence of copper.	Copper can be both a pollutant and naturally occurring. Unnatural occurrences can result by acid mine drainage or oil-well runoff.
Foam		Excessive foam is usually the result of soap and detergent pollution. Moderate levels of foam can also result from decaying algae, which indicates nutrient pollution.
Multi-Coloured (oily sheen)	Indicates the presence of oil or gasoline floating on the surface of the water. Oil and gasoline can cause poisoning, internal burning of the gastrointestinal tract and stomach ulcers.	Oil and gasoline pollution can be caused by oil drilling and mining practices, leaks in fuel lines and underground storage tanks, automotive junk yards, nearby service stations, wastes from ships, or runoff from impervious roads and parking lot surfaces.
No unusual colour	Not necessarily an indicator of clean water.	Many pesticides, herbicides, chemicals, and other pollutants are colorless or produce no visible signs of contamination.

Chemical monitoring

uses the Water Quality Test Kit containing the tools and chemicals to accurately assess and analyze the river water quality at that point of time.

PARAMETER	INDICATES	POSSIBLE CAUSES
pH	Indicates the river water's acidity or alkaline through the concentration of hydrogen ions (H +).	Geology and soils of the watershed, the concentration of carbon dioxide in the water, air pollution.
Dissolved Oxygen	Determine the water body's ability to support aquatic life.	Volume and velocity of water flowing in the water body, climate/weather, riparian vegetation, the type and number of organisms in the water body, altitude, organic wastes, dissolved or suspended solids, amount of nutrients in the water.
Phosphate	An important nutrient that acts as a fertilizer for aquatic plants.	Wastewater and septic system effluent, detergents, fertilizers, animal waste, development/paved surfaces, industrial discharge, phosphate mining, drinking water treatment, synthetic materials.
Nitrate	Growth of algae.	It is natural occurring, but wastewater and septic system effluent, fertilizer runoff, animal waste, fossil fuels, industrial discharge.
Turbidity	Depending on the clarity of water (the amount of light that can traverse the water and is directly used for the process of photosynthesis).	High flow rates, soil erosion, urban runoff & flooding, wastewater and septic system effluent, decaying plants and animals, bottom-feeding fish, and algal blooms.
Temperature	Determine the suitable temperature for aquatic life.	Paved surfaces and industrial discharge, overhanging trees and riparian vegetation. The season and flow rate affects the temperature.

Chemical monitoring using the Water Quality Test Kit*

PARAMETER	STEPS	
pH 	1. Fill the test tube until the 10ml line. 2. Add one pH Wide Range TesTab®.	3. Cap the tube and mix by gently shaking the test tube until the tablet have disintegrated. 4. Compare the colour of the sample to the pH Colour Chart and record the result as pH.
Dissolved Oxygen 	1. Fill the test tube until it is full. 2. Add two Dissolved Oxygen TesTabs® to the test tube. 3. Cap the tube. Make sure there is no air bubbles in the water sample.	4. Mix by gently shaking the test tube until the tablets have disintegrated (about 4 minutes). 5. Wait for 5 minutes and observe the colour of the water change. 6. Compare the colour of the sample to the Dissolved Oxygen Colour Chart and record the result as ppm Dissolved Oxygen.
Phosphate 	1. Fill the test tube until the 5ml line. 2. Add one Phosphorus TesTab®. 3. Cap the tube and mix by gently shaking the test tube until the tablet have disintegrated.	4. Wait 5 minutes and observe the colour of the water change. 5. Compare the colour of the sample to the Phosphate Colour Chart and record the result as ppm Phosphate.
Nitrate 	1. Fill the test tube until the 5ml line. 2. Add one Nitrate #1 TesTab® . 3. Cap the tube and mix by gently shaking the test tube until the tablet have disintegrated.	4. Wait 5 minutes and observe the colour of the water change. 5. Compare the colour of the sample to the Nitrate Colour Chart and record the result as ppm Nitrate.
Turbidity 	1. Fill the Water Quality Test Kit container 3/4 full of sample water.	2. Hold the Turbidity Chart on the top edge of the jar. Looking down into the jar, compare the appearance of the secchi disc in the container to the chart. Record the result as Turbidity in JTU.
Temperature 	1. Place the thermometer below water surface (10 cm) for 1 minute.	2. Keep the thermometer in the water until a constant reading is attained. 3. Remove the thermometer from the water. Read the temperature (green indicator) and record the results as °C.

Biological monitoring

observes the life of the river. This method focuses on analysing the river and its basin's health. Biological monitoring can be carried out at any part of the river as it is based on the living organisms presence in the water or surrounding area. There is two groups of organisms that can be found in the river: aquatic macroinvertebrates and fishes.

The aquatic macroinvertebrates presence is used as a river water quality indicator, clean or otherwise. It is used to show short-term pollution effects while fishes are used for long-term monitoring.

The presence of an aquatic macroinvertebrates can indicate the true biological water quality. Biological Water Quality Index (BWQI) of a river can be determined by calculating the biological indicator score value by referring to the visuals here, identifying the organism sample score and calculating the total before dividing by the quantity of the sampled organism (one sample for each species).

Biological methods

Make sure the sample collecting equipments are ready and each container contains water to store the captured sample. Every organism found should be taken with forceps or fingers and always be careful to not damage the sample.

Hide and seek

Good rivers usually have stones, leaves and driftwood where invertebrates like to hide under and around it. Be careful when checking the area under the big rocks by slowly lifting it and remember to put it back in its original place gently.

Sifting

Dig the bottom of the river about 2 - 3cm deep and sift out the sand / soil by sifting. Gently separate the organisms from materials such as waste, soil and sand to facilitate the identification process.

Net

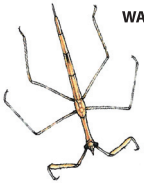
Hold the net vertically and face against streamflow to be catch microinvertebrate that are swimming or hiding in the crevices of the water plants.

Biological indicators score

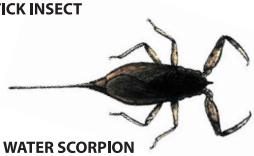
INSECTS

5

COMMON SAUCER BUG



WATER STICK INSECT



WATER SCORPION

5

GREATER WATER BOATMAN

LESSER WATER BOATMAN

POND SKATER

WATER CRICKET

WATER MEASURER

WHIRLGIG BEETLE

MOLLUSCS

6

SWAN MUSSEL

PAGODA SNAIL

3

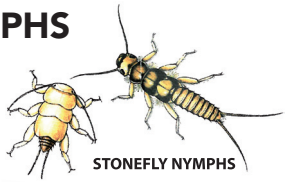
PEA COCKLE

RAMHORN SNAIL

MYSTERY SNAIL

POND SNAIL

NYMPHS



10

STONEFLY NYMPHS

BURROWING MAYFLY

SWIMMING MAYFLY

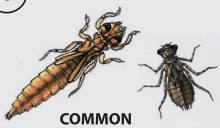
PRONG-GILLED MAYFLY

SPINY CRAWLING MAYFLY

FLATTENED MAYFLY

8

ONE-TAILED DRAGONFLY



COMMON DRAGONFLIES

COMMON DEMOISELLE

6

TWO-TAILED DEMOISELLE

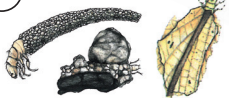
COMMON DAMSELFLY

BALLOON-TAILED DAMSELFLY

LARVAE

LONG-HEADED CADDISFLY LARVAE

10



CASED-CADDISFLY LARVAE

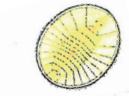
DOBSONFLY LARVAE

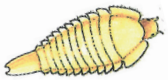
9

ALDER FLY LARVAE

7

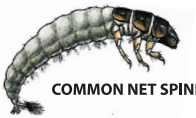
5


WATER PENNY LARVAE


RIFFLE BEETLE LARVAE


DIVING BEETLE LARVAE


WHIRLGIG BEETLE LARVAE


COMMON NET SPINNER


MIDGE PUPA


HORSEFLY LARVAE


BLACKFLY LARVAE


CRANEFLY LARVAE


BITING MIDGE LARVAE


PHANTOM MIDGE LARVAE


MOTH LARVAE

3

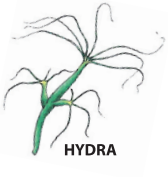

RAT-TAILED MAGGOT LARVAE

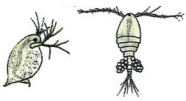
2


NON-BITING MIDGE LARVAE

SMALL ANIMALS

5


HYDRA

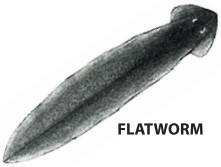

WATER FLEA

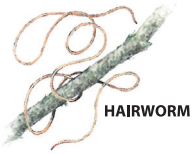

WATER SPIDER


WATER MITE

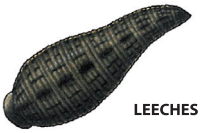
WORMS

5

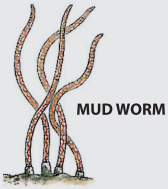




3

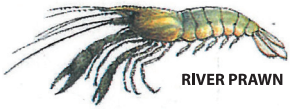


1

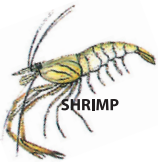


CRUSTACEAN

8



4



3

BWQI	INDICATOR	WATER QUALITY
7.6 - 10	Very sensitive	Very clean water
5.1 - 7.5	Sensitive	Clean water
2.6 - 5.0	Average	Average
1.0 - 2.5	Less sensitive	Dirty water

BWQI: Biological Water Quality Index

Pollution reduction

Pollution reduction for this context focused at solid waste and liquid waste reduction. This can be done through:

Pollution control at source

- Solid waste and liquid waste are the types of waste that usually pollute the river but they are being initiated by our own activities.
- We can manage our waste by 4R2C approach that initiated under GEC's SMART Ranger Programme (please refer to GEC's SMART Ranger module for details):

R (Rethink)

R (Reduce)

R (Reuse)

R (Recycle)

C (Compost)

C (Closing the loop)

Pollution control at river banks

- Simple yet effective community engagements such as river clean-up, plogging or any other appropriate activities can be carried out to control solid waste ending up in the river.
- River clean up activity:
  - Need to be done at least monthly as one time event won't be successful. Education elements are also need to be incorporated within so that, the target of getting clean river will be achieved.
  - If possible, utilize and involve direct beneficiaries (communities in that area) so that they become eyes and ears of the river.
- Plogging Is an activity combining jogging and picking up litter:
  - Can be carried out at any suitable places such as roads, jogging trails, drains etc.
  - This also can solve non-point source pollution issues which rubbish being thrown to land and drain, eventually goes to river.

Proactive

In our country or in almost all countries, the action towards any environmental problems is reactive in nature. Reactive means we find solution or act after we are affected by an issue. For instance, we only clean up a stream or river, after it is severely polluted due to our own activities. This scenario needs to be changed if we want all our rivers to be at desirable targets. The only way is being proactive, which is taking preventive actions even before the crisis. Since 2002, concept of 'Friends of Rivers' was actively being promoted as proactive approach by GEC through RIVER Ranger programme.

Through 'Friends of River' group, all key stakeholders such as communities, government agencies, private partners and community-based organisations (CBO) can be brought in together to protect the particular river/waterbodies at their respective vicinities.

Some of the key initiatives through 'Friends of Rivers' that can be carried out:

River adoption

- Community or key stakeholders involved need to identify river stretch that they can adopt.
- Adoption will make sure they are committed to care for that particular stretch and can cover whole river with adoption by different parties for various stretches (Chain mechanism).
- With this, they can plan their action plans based on issues identified at their respective vicinities.

River Restoration

- Usually, source of rivers that is in very good status might need simple restoration for it to be ecologically rich mainly though the presence of good biological indicators.
- Take note the restoration must be done using biological as well as environmental friendly or site-specific approaches such as wetland planting. Artificial structures such as roads, trail building etc not encouraged as it won't serve the intended purpose.
- The river restoration done must have a clear target and need to be carried out a number of times.
- A river source area restoration also can be turned into a river open classroom for public to learn about rivers in an experiential manner.

River Rehabilitation

- The polluted stretch must be promoted for rehabilitation effort.
- This can be done in bigger or smaller scale.
- Bigger scale demands higher budget, larger labor force and support from relevant agencies.
- Small scale initiatives such as monthly river clean up, community gardening at river bank, rubbish fishing, alien fish collecting and others can be done as part of community initiatives for river care.
- Pollution reporting is also key part of this initiative as community can be the eyes and ears of the river to prevent further degradation of river water quality due to human activities. Immediate reporting to relevant agencies can prevent this.

History fact

Some of the logos.

'Friends of Kelana Jaya Park' is the first group in Malaysia that was formally registered in 2002 under GEC and there were so many groups (in the names of Friends / Sahabat Sungai) since then till now.

River Care
WE CARE

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