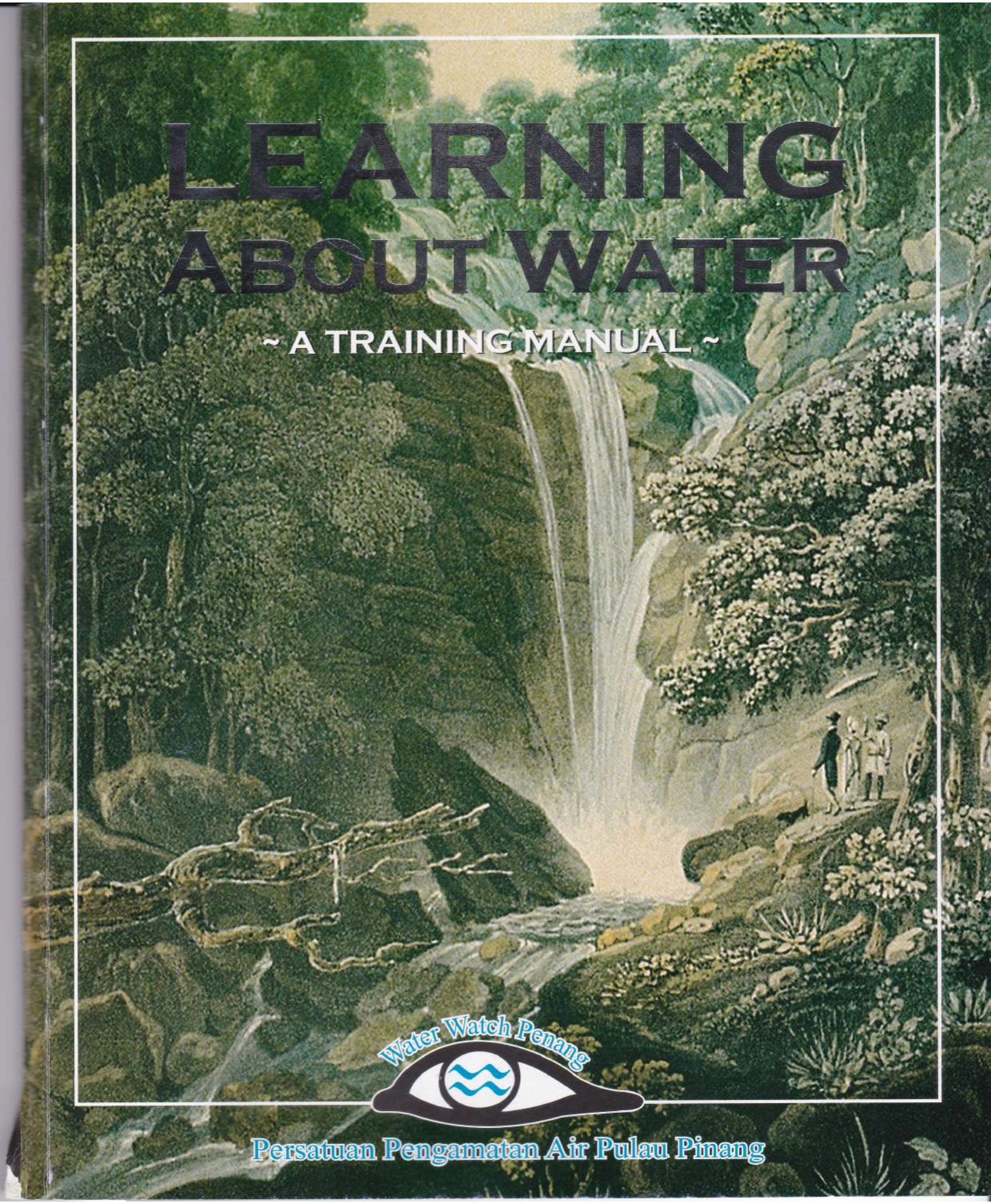
LEARNING
ABOUT WATER
~ A TRAINING MANUAL ~
Water Watch Penang
Persatuan Pengamatan Air Pulau Pinang

ACKNOWLEDGEMENTS

The publication of this manual has been made possible with the help and assistance of many parties. First and foremost, Water Watch Penang, would like to thank the FORD Foundation for the grant which funded our initial fieldwork programme with the school children and for the subsequent funding which has made this publication possible. Water Watch Penang would also like to say "Thank You" to Professor Dr Chan Ngai Weng, Dato' (Dr) Anwar Fazal, Dr Hajar Abdul Rahim, Khor Hung Teik and Baharulnizam Baharum for putting the manual together. Many thanks to Lee Shok Mee, Yeoh Oon Bee, Dorothy Teng Fong Yi and Rohana Abdul Aziz for being facilitators during the fieldwork and various other phases leading to this publication. Water Watch Penang is grateful to the Socio-Economic & Environmental Research Institute (SERI) for the secretarial and other support given. We also wish to record our thanks to Mr Khoo Boo Chia, the Director of the State Museum Board, Penang for allowing the reprint of William Daniell's "View of the Cascade, Prince of Wale's Island" painting which adorns the cover of the manual. To all the school children who took part in the programme, as well as all parties that have contributed in one way or another, Water Watch Penang wishes all of you "Ribuan Terima Kasih" and hopes that you will continue to support us and our efforts in making Malaysian society a "Water Saving Society".

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Front Cover:
William Daniell's "View of the Cascade, Prince of Wale's Island" (1818 Aquatint, 1821

From the collection of
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Penang

CONTENTS

FOREWORD

BY DATO' (DR) ANWAR FAZAL, ADVISOR, WATER WATCH PENANG

(Dato' (Dr) Anwar Fazal is a former President of the International Organisation of Consumers Unions and a recipient of the Right Livelihood Award popularly known as the "Alternative Nobel Prize".)

The governance of water is going to be one of the central survival issues of humanity. Water is the source of life and yet we recklessly poison it, misuse it and also fight over it. All over the world there is a new recognition about the importance of water. People are even discovering that our bodies are also mostly water!

We need a holistic approach to understanding and managing water and there are at least three challenges:

- Most people are seriously ignorant about the issue of water in its totality.
- Its borderless character transcends, local and national political boundaries.
- It is a "common or public" good as well as increasingly an "economic" and "private" good. And there are deep concerns about the "corporate hijacking" of water services and the fear that "cash register ethics" will prevail over conservation and care of the environment.

One could articulate the key principles of water as follows - I call them the "panchasila" (or five principles) of water:

1. We must respect the right of water – it is sacred and it is life.
2. We must ensure the right to water – that no person is denied access to it for their survival and health needs.
3. Water resources must be managed with efficiency, effectiveness and equity.
4. People who manage water must be trained holistically about water and must be made accountable for its care and conservation.
5. There must be popular participation of all the stake holders, citizens, government and corporations to ensure a community based approach to the care and management of the water cycle.

The best elaboration of this "Panchasila of Water" comes in the form of a global statement which is widely accepted by well informed and progressive thinkers and citizens groups. It is called "Water is Life – A Civil Society World Water Vision for Action". The essential elements of the vision are as follows:

"Water belongs to the earth and all species for all time. It is an inalienable human right and a public trust to be protected and nurtured by all peoples, communities and nations, and the bodies that represent them at the local, state and international levels. Based on these unwavering principles, we make the following claims:

- *Water is not a commodity and must not be left to the whims of the market because no person or entity has the right to profit from it. Water must not, therefore, be commodified, privatized, traded or exported for commercial gain. Water must be excluded as "goods", a "service" and an "investment" in all international, regional and bilateral trade agreements.*

- *Every human being has the right to clean water. We demand that governments of the world substantially increase spending on clean water and sanitation for poor people who have little or no access to it. We affirm that by reducing current astronomical levels of military spending, clean and safe water can be provided for every living person on this planet. We maintain that debt cancellation is essential for water security in poor countries, and demand that privatization cease to be used as a condition for international lending. Furthermore, we believe that a tax on international currency speculation and a reduction and redirection of military spending, particularly by the world's largest military powers could pay for water services around the world.*

- *We proclaim that the key to the sustainable provision of water for life is the maintenance and protection of the ecological integrity of all ecosystems. We call for the adoption and implementation of a restoration agenda for the rehabilitation of degraded ecosystems. Further, we proclaim that a water-secure future is incompatible with industrial farming and the monopoly control of food and seeds by a small number of corporations. We support the goal of consider local self-reliance in food production. We also consider large-scale water development projects such as mega-dams to be ecologically and socially unsustainable. As such, a water-secure future is dependent upon the acknowledgement, respect and protection of the rights of indigenous, peasant and fisher peoples and their traditional knowledge. We insist that the voices of these groups and of women around the world be given a central place in water management issues, as these are the communities most affected by water insecurity.*

- *Water, as a public trust and an inalienable human right, must be controlled by the peoples and communities that rely on it for their lives and livelihoods. The*

management of water services must not only remain in public hands, but must be revitalized and strengthened to make community and worker participation central in order to democratize decision-making processes and ensure transparency and accountability. This participation must be extended to the state, regional and international levels in all decisions pertaining to water resources, and should be governed by an international legal instrument binding all states and peoples to these principles. Furthermore, all water resources development projects must be based on respect for the rights of affected communities and must provide full and meaningful participation and decision-making.

Finally, we proclaim that the management and protection of the world's water resources must absolutely be based on the principles of justice, solidarity, reciprocity, equity, diversity and sustainability, because water is a human right."

Penang has been fortunate with water – a beautiful combination of sea and hills, and a generous hinterland, has provided our island with an abundance of water for the "life giving and protecting", industrial and agricultural uses, and for recreational and scenic purposes.

We have however also privatized our water supply bringing new uncertainties and challenges.

Our hope is that we will be guided by the civil society world water vision that "Water is life and not money!"

Let Penang lead in making this vision a reality.

22nd March 2003
World Water Day
Penang
Malaysia

CHAPTER 1

INTRODUCTION

EVERYONE HAS A ROLE TO PLAY IN CONSERVING WATER. PARTICIPATION IN ANY WATER CAMPAIGN OR ACTIVITIES CAN MAKE A BIG DIFFERENCE. A STEP TAKEN TODAY TO CONSERVE WATER GIVES US HOPE FOR OUR FUTURE GENERATIONS.

As the pioneering non-governmental body for water-related issues in Penang, Water Watch Penang (WWP) is interested in raising the awareness of water conservation in the community. With this in mind, WWP mooted the Youth Action for Water Programme to encourage school students and youths' involvement in water conservation. The programme is aimed at helping youths make a difference in their community with regard to water concerns and to become active citizens and stewards of the environment. The main objective of the programme is to raise awareness in youths of the importance of water and also to provide them with ideas to work with in school, at home and in the community.

One of the activities organized by WWP under the Youth Action for Water umbrella is the "Active Watershed Education" (AWE) Project, funded by the FORD Conservation and Environmental Grants. The project was designed to promote interest in water conservation among youths, particularly students, and also to enhance their knowledge of local water issues. The objectives of the AWE project includes:

- To provide students with relevant and empowering educational experience in the protection of watersheds and other water resources.
- To involve youths in investigating and acting on local water issues.
- To encourage volunteerism among young members of the community.
- To establish and encourage links between youths, the community and natural resource professionals.

The project was successfully carried out in 2001 during a three-day Student Water Camp at the Universiti Sains Malaysia Experimental Station in Muka Head, Penang. The success of the activities that were carried out and the experiences gained by the participants, whom were mostly school students, demonstrate that youths are willing and able to participate actively in water conservation activities.

Given the success of the AWE project, WWP would like to see more of this form of activity carried out by other organizations/units such as schools and residential communities. In addition, support from various bodies (private sectors, public and NGOs) is needed to ensure that water conservation activities, such as the water project, can be continuously and successfully carried out in the community.

This manual is WWP's initiative towards that support. It is drawn up based on the experiences that WWP gained from the Active Watershed Education Project. The main aim of the manual is to provide a guide for teachers and facilitators who would like to run a water awareness programme in their school or community.

The manual is divided into two main parts. The first part provides basic and relevant information about water and water-related issues in our community that should be accessible to anyone who is keen on water conservation. The second part of the manual is a step-by-step guide for running a watershed project. The guide is designed to be user friendly so that teachers and facilitators could use it even if they have fairly young members participating in their project.

CHAPTER 2

WATER FACTS

EARTH: A BLUE PLANET

Earth is the only "Blue Planet" in the universe known to man (Diagram 1).

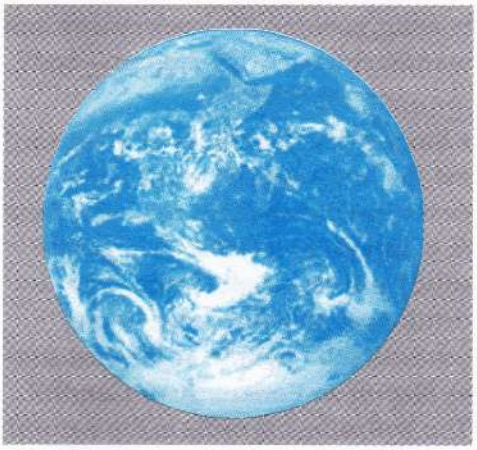


Diagram 1: Earth - A Blue Planet.

Hence, it is the only known planet with Water and Life. As a "Water Planet", Earth is teeming with an abundance of life ranging from tiny amoebas to giant whales. The total amount of water on Earth is a staggering 1.36 billion cubic kilometers of water, and this volume has remained almost constant since it attained this volume some 2 billion years ago. Water is recycled in the atmosphere, hydrosphere, biosphere, cryiosphere (ice) and lithosphere via the hydrological cycle (Diagram 2). According to scientific evidence, much of Earth's water originated from icy comets. The total amount of freshwater available for all life is limited. Of all the water on earth, only 2.5 % is freshwater and 97.5 % seawater. Of the total amount of freshwater, 69 % is stored as ice, icebergs, glaciers and snow and 30 % stored as groundwater. Hence, only less than 1 % of total freshwater is surface freshwater available for life (Diagram 3).

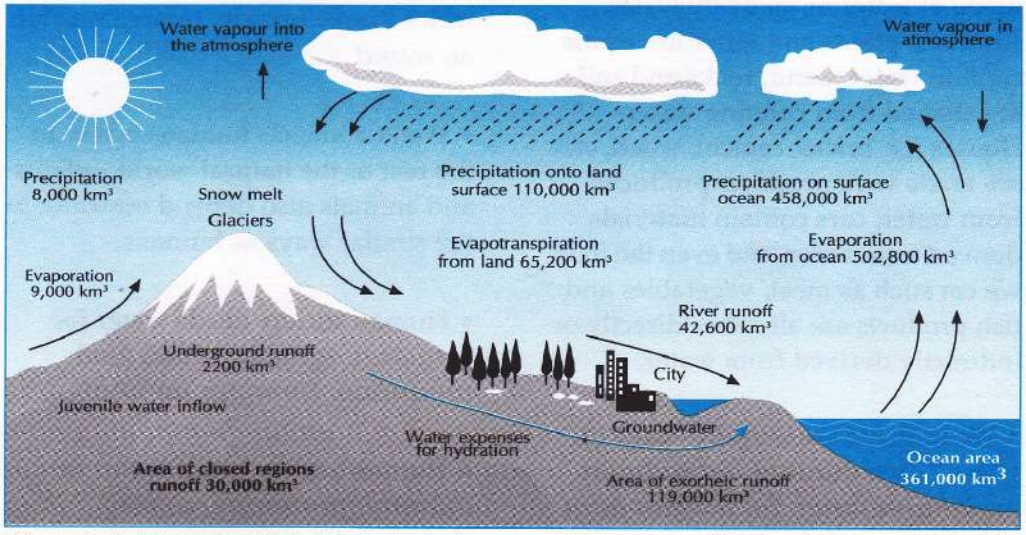
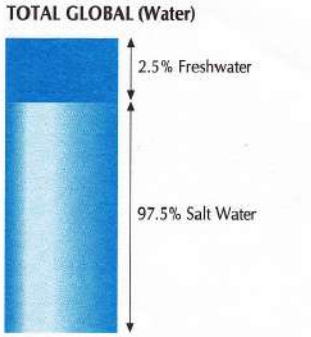


Diagram 2: The Hydrological Cycle "Recyles" water from oceans to atmosphere and back again in an everlasting cycle.



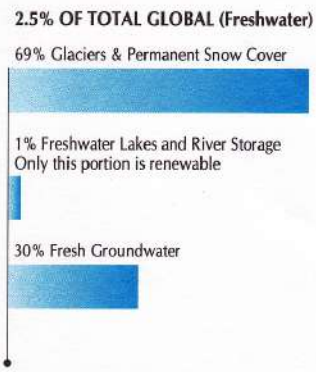


Diagram 3: Total Amount of Available Water is extremely small at 1% of the 2.5 % of total global freshwater.

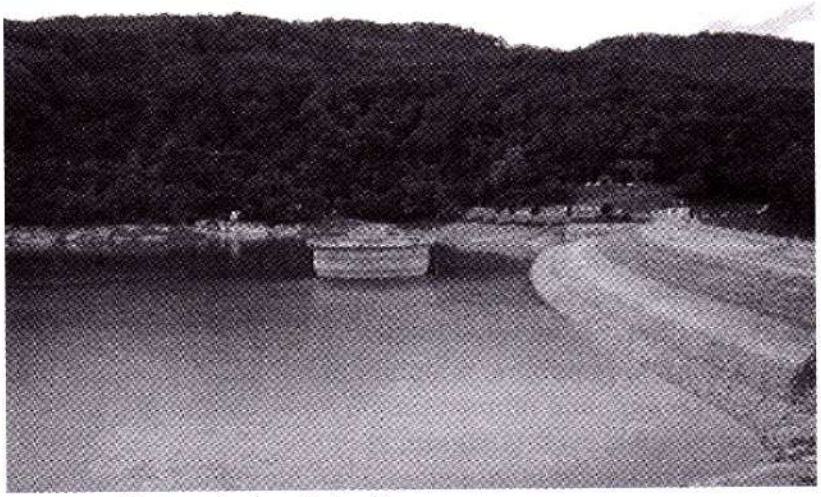


Diagram 4: Water supply from Air Itam Dam.

WHY IS WATER SO IMPORTANT?

• Without water there is no life! That is how important water is. Wherever there is water, life is flourishing but wherever there is no water or a lack of water, life is scarce.

• Almost everything on Earth is either made of water or made by water. Animals, plants and other life forms contain water. Land, rocks and soil are shaped from running water. Houses (i.e. bricks, cement, wood, etc) are made with products produced from water, cars contain materials derived from water, and even the food we eat such as meat, vegetables and fish products are all either directly or indirectly derived from water.

• We humans are literally "Bags of water"! Two thirds of our bodies is made up of water. So, humans don't just drink or use water, humans are water! People depend on water for drinking, cleaning, irrigation and processing food, growing fibrous plants for cloth, transportation, tourism, fishing (food and recreation), boating, cooking, hydroelectricity and manufacturing of all modern goods.

• Since every drop of water is recycled via the hydrological cycle, water is never lost but changes from one form (e.g. liquid) to another (e.g. gas or solid) and recycled. Hence, what we drink now may have been water consumed by people in the past such as Napoleon Bonaparte or Gandhi! The hydrological cycle is the natural example of recycling. But pollution can render water undrinkable even though the volume remains unchanged.

• There is no development without water. Name one city or area that has no water!

• Water connects human society to the rest of the natural world - plants and animals also depend on water in the similar ways as humans.

• Human society needs water for irrigation, agriculture and food processing. No water, no food!

• Human society needs water for industry (processing, cooling, cleaning, diluting, etc).

- Human society uses water (e.g. lakes, sea, rivers, wetlands, etc) for tourism and recreation.

- Human society uses water for transportation (e.g. the Great Lakes-St Lawrence route, the oceans and other great rivers) (Diagram 5).

- Human society uses water to generate power via hydroelectricity, which is in turn used in homes and industries in manufacturing of all modern goods.

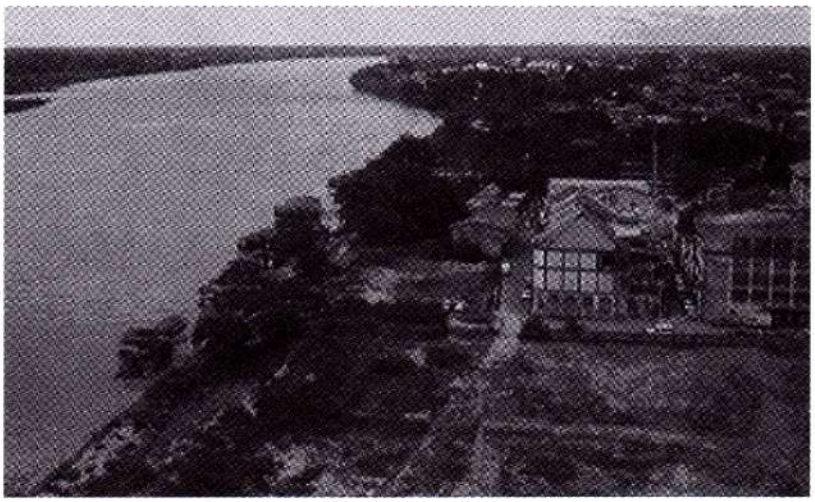


Diagram 5: Sungai Kelantan is used for fishing and transportation.

WHAT IS WRONG WITH OUR WATER?

Unequal Distribution

Water is distributed unequally over space and time. Some countries are rich in water resources (e.g. those located in equatorial regions) but some are poor (e.g. those located in desert climates). Consequently, some countries have droughts but others have floods.

Water Scarcity

There is enough water for everybody's need but not enough for everybody's greed. Water scarcity is in fact a result of excessive exploitation. Water-rich countries and water-rich states (within a country) over-exploit water resources resulting in depletion and scarcity.

Water Rationing

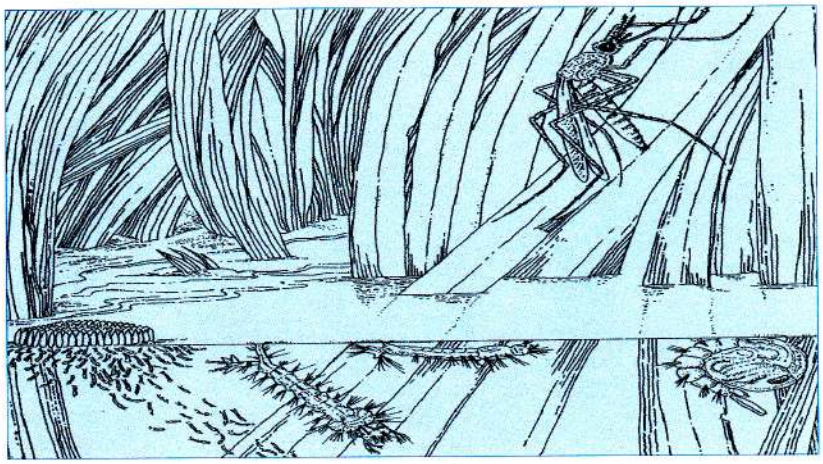
Water rationing is becoming an inevitable facet of city life in many developing countries. This is not only causing hardships but affecting public health (both physically and mentally) and stunting industry.

Pollution

The World Commission on Water for the 21st Century warns that more than one-half of the world's major rivers are being seriously depleted and polluted, degrading and poisoning the surrounding ecosystems, thus threatening the health and livelihood of people who depend upon them.

Poor Water Quality

Public water supplies are poor in quality due to rusty pipes, pollution caused by constant repairs, contamination due to mixing of water supply and sewerage waters (due to leakage of both), flooding and common out-of-date treatment facilities.



Water-borne Diseases
Contaminated water can kill. About 80 % of diseases throughout the world are water-related. Waterborne diseases such as cholera, schistosomiasis (or bilharzias), diarrhoea, yellow fever, malaria, river blindness (onchocerciasis), liver fluke infections, JE and Nipah virus kill millions each year. Chemicals (e.g. heavy metals) and biological contamination (e.g. coliform) also take the lives of millions each year.

Privatisation
Governments the world over are trying to privatize the water industry like many other public utilities, in order to cut expenditure and increase revenue. Privatization has proven successful in many developed countries but at the same time has also been unsuccessful in developing countries.

Bad Management
Bad management of water resources is destroying water catchments, polluting water sources, depleting water supplies, causing land subsidence (in the case of groundwater), water supply cuts, water rationing, high rate of non-revenue water and huge losses in public investments.

Destruction Of Water Catchments
Deforestation is by far the biggest threat to water catchments. Others include pollution, land clearance for farming, hill resort development, forest fires, acid rain, etc.

Non-revenue Water
The amount of non-revenue water (NRW) or water that is lost either through breakage, theft, seepage or other unaccountable ways after leaving the treatment plant is very high. For many developing countries, the average NRW can be as high as 40 % while the extreme cases register NRW rates is more than 50 %. Reducing NRW can mean doing away with building new dams.

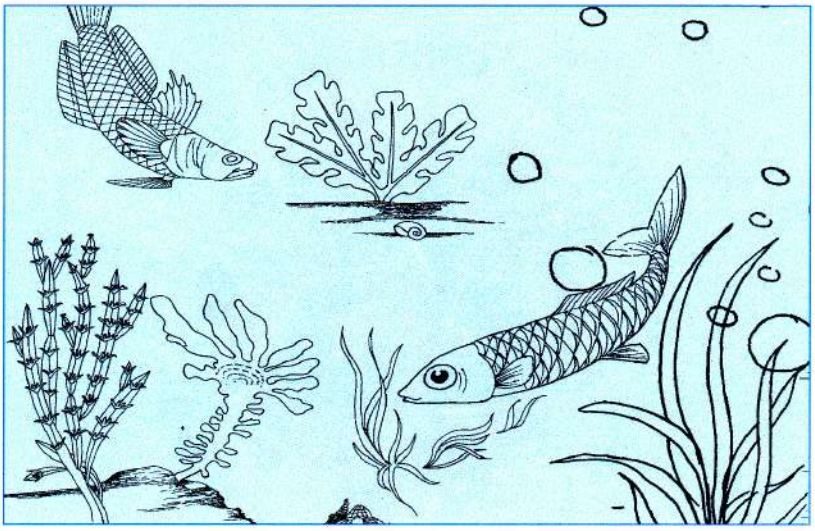
Public Apathy
Public apathy is a major reason for much of the world's water woes. The international standard is 165 litres per capita per day (LPCD), but people in the developed world use more than 1000 LPCD. Even in rapidly developing countries in Asia, the average usage is more than 300 LPCD although the average usage in Africa and India is 50 and 100 LPCD respectively. Farmers are also responsible for loading pesticides, weedicides and chemicals into the water system. Littering and illegal rubbish disposal are also polluting our waters.

HOW CAN HUMAN SOCIETY SOLVE ITS WATER PROBLEMS?

Water Sharing
Water can be shared by countries (in the case of river basins cutting across boundaries) as well as by states within a country. Water can be transported via international mains or inter-state transfer (via rivers, canals, mains, etc).

Water Abundance
If humans manage water resources sustainably and users practise water conservation, there should be enough water for everybody's need, even in countries with desert-like climates. Alternative sources of water such as lakes, ponds, groundwater, desalination of sea water, etc should be explored.

Uninterrupted Supplies
More efficient management using state-of-the-art technologies should ensure uninterrupted water supplies. Non-revenue water needs to be reduced to an acceptable level of less than 20%. Water rationing for extended periods is not acceptable. Water authorities and water companies should be held accountable for any mishap that causes hardships and endanger public health (both physically and mentally).



Clean And Free Rivers
Clean, crystal-clear and free flowing rivers are possible. In their natural state, rivers used to be like that. In the past, our rivers used to be in such a healthy state. There is no reason why we cannot restore our rives to their natural state if we put our minds to it.

Good Water Quality
Good water quality and adequate water are basic human rights. Good clean water is essential for our physical and mental well being, not to mention vital for all developments in human society.

Affordable Water
While it is necessary to raise the price of water to a level that reflects the true costs of supply as well as to deter wastage, it is necessary to ensure that the price is not prohibitive to the extent of depriving the poor.

Equitable Access
Everybody must have equal access to water. The poor must not be deprived.

Smart Privatisation
Water is an essential and vital resource. It is the moral responsibility of elected governments to ensure people get their water supplies without problems. Governments must ensure that privatization is transparent and professional, and companies awarded contracts be held accountable and not pass their losses on to taxpayers.

Public Participation
The public must be allowed to play a greater role in the decision-making and management of water resources. Effective water management involves a smart-partnership between government, industry and the public. Supply management (government and industry) is no longer adequate and demand management (public participation) is necessary to complement the supply side. Unless the public co-operates, no water management scheme will succeed.

Catchment Protection
Water catchments need to be gazetted in order to protect them from pollution, encroachment and destruction. Threats such as pollution, land clearance for farming, hill resort development, forest fires, acid rain, etc need to be tackled.

A Water Saving Society
All societies need to evolve from the present largely "Water Wasting Societies" to "Water Saving Societies. This is not an impossible dream if we put our minds and efforts to it. All levels of society must endeavour to create this water saving society. More importantly, changing our life styles by practising the 3Rs lifestyle - Reduce, Reuse and Recycle will contribute towards the attainment of this society as almost all consumables involve using water to produce.

CHAPTER 3

STEP-BY-STEP GUIDE FOR TEACHERS/FACILITATORS

STEP 1: UNDERSTANDING YOUR WATERSHED AND WHERE YOUR WATER COMES FROM

To many ignorant people, water comes out from taps and faucets! This cannot be further from the truth. You need to get out of your house and identify the watershed (i.e the area of land where all water drains or "sheds" to the same water body. In many cases, it is equal to the river basin from which your water comes). Once you have identified your watershed, you also need to understand how water is extracted from the river (via intakes by the water authority), impounded in reservoirs or dams, treated in water treatment plants and then piped out to you and other consumers.

What You Need To Do:

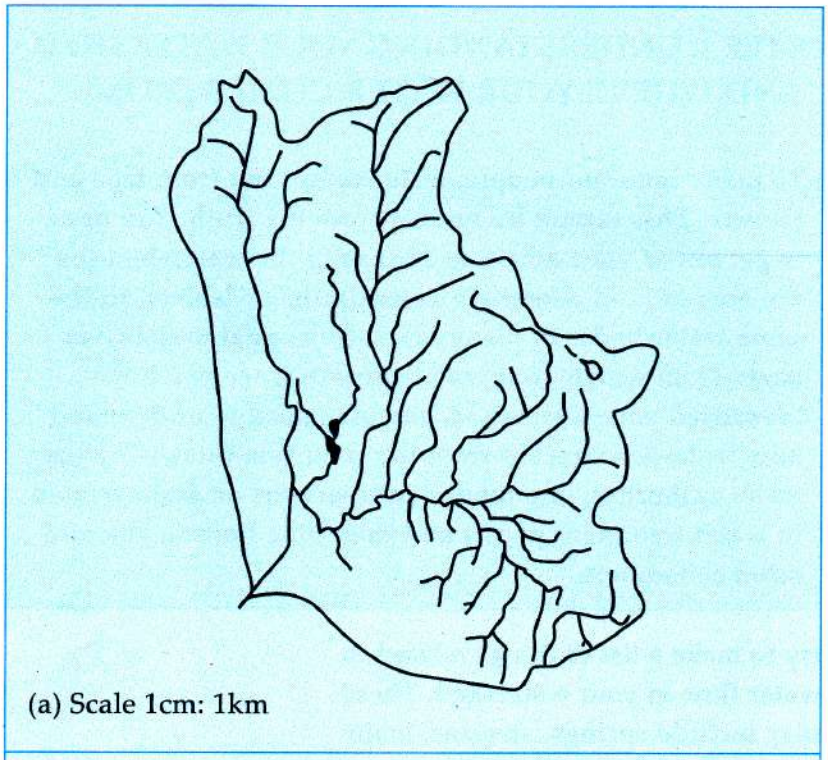
A. Identify which river and watershed your piped water is extracted from. Simply call your water authority/ supplier and enquire. Then look it up in a topographical map.

B. Once you have identified your watershed and river, go to the highest point in your watershed (for example, if you live in the Air Itam area in Penang, your highest point would be the Air Itam Dam). Here, look around you and notice all the streams and rivers draining from the mountains and hills into the main river or dam.

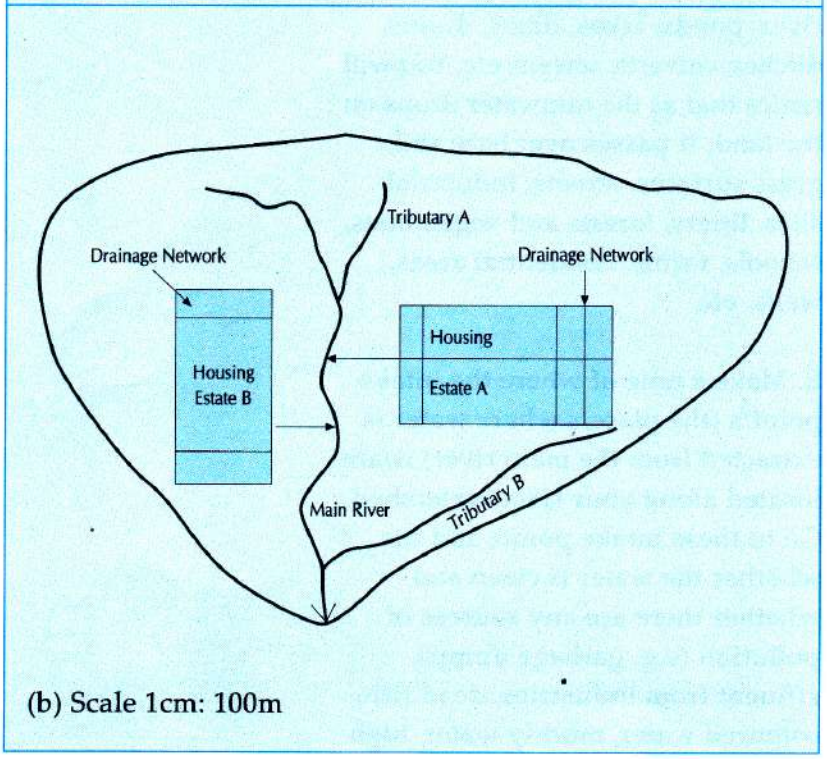
C. If you want a better picture, go to the highest point in your watershed when it is raining. Then look over the land and the way the ground slopes down from this high point, and how and where the rainwater flows. If there are 3 streams, then you can even divide your watershed into three sub-watersheds, for example sub-watershed of River A, B and C. When you are looking at these 3 watersheds, you are looking at your entire watershed.

D. Walk around your watershed (or part of your immediate watershed if your watershed is a large one) and try to make a list of things related to water flow in your watershed. These may include springs, streams, main river, ponds, lakes, dams, drains, ditches, culverts, sewers, etc. You will notice that as the rainwater drops on the land, it passes over bare soil, grass surfaces, streets, industrial sites, litters, forests and vegetations, schools, farms, residential areas, wells, etc.

E. Make a note of where the intake point/s (the place/s where water is extracted from the main river) is/are located along your river/watershed. Go to these intake points and see whether the water is clean and whether there are any sources of pollution (e.g. garbage dumps, effluent from industries, dead fish, coloured water, muddy water, high sedimentation, etc).



(a) Scale 1cm: 1km



(b) Scale 1cm: 100m

F. Try to draw a sketch map of your watershed, the main river and the intake points. If you have a camera, take some photographs of these locations. Your diagram should look like Diagram 6 (a).

G. From your observation, is there soil erosion, sedimentation, floating garbage, carcasses of animals, foam, dead fish, etc in the river? If so, make a note.

H. When you get home, get your parents, neighbours and friends together to brainstorm your concerns about your watershed. Make a list of the ways in which your community could address the problems. See how many ideas you can generate. (For example, what activities use water? How much water does each family use? What are the activities that create wastewater? Is the wastewater treated before being discharged? Do you use your river for recreation? What does each family do to conserve or protect water? What extra things can the community do to ensure sustainable water supply?)

 Diagram 6: (a) A sketch map of a watershed. (b) A sketch map of a local watershed.

STEP 2: FINDING OUT HOW PEOPLE USE WATER, ABUSE WATER AND HOW YOUR WATERSHED IS PROTECTED

Objective: After you have obtained a greater understanding of your watershed from Step 1, you should start to look at ways you and communities in your watershed use water, abuse water and whether or not people are protecting watersheds, water sources and find out why people are or are not doing so. You may also begin to investigate the main issues and problems connected to water.

To Carry Out This Activity, All You Have To Do Is:

A. Choose a site for your project (this can be your immediate neighbourhood or your school) where there are many people you can talk to.

B. Draw up a questionnaire to survey how people use, protect and manage water (see example on the following page).

C. Make a checklist (refer to Diagram 7) about the issues and problems related to water that you notice in your area (The checklist may differ from one site to another. The example is only a guide for you. You may add or delete questions as necessary). The checklist should be used together with the site map.

D. Make a site map of the area you are about to survey. This can be the housing area you live or your school. Draw/sketch the map yourself or request it from your town council/ municipality (or you can just buy a street map of your area). In the case of your school, ask your teacher or headmaster to provide you a copy of the school map. Maps can often be out of date as new buildings or roads are built. See if you can add in new features on the map. In your map, be sure to label all places related to water and where water is used. Make a note of where the main pipes are located, the water meter, ponds, wells, river, drains, fountain, etc. If you're working outside, include things like trees, fields, car parks, buildings, gardens, storm sewers or anything else (related to water) that you observe on the site (Diagram 7).

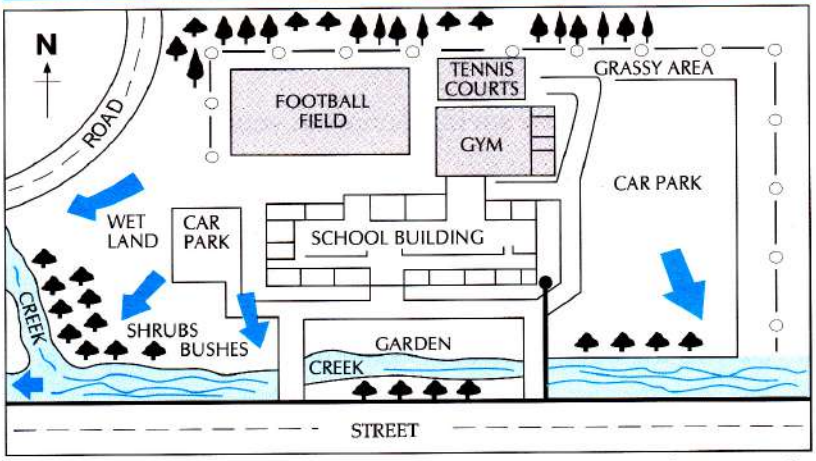
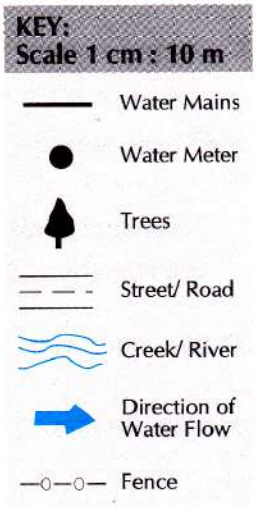


Diagram 7: Example of a school site-map and checklist (the checklist in this case are the identified features).



E. Often it is more fun and safer to work as a group. Appoint your Group Leader, go out to the selected site/field and complete your checklist and map.

Example of a questionnaire in the house:

1. How much is your household's monthly water bill? RM_____

2. How much is your household per capita water use per day in litres per day (LPD)?
   _____ LPD (Use the amount of water consumed for the whole month and divide it by the number of days, and then divide it again by the number of persons in the house.)

3. Do you practise any form of water conservation?
   Yes, specify_____ No_____

4. Are there any water saving devices in your house?
   Yes, specify_____ No_____

5. Do you have a well?
   Yes_____ No_____

6. Do you use other sources of water (e.g. well, river, spring, collect rainwater, etc)?
   Yes, specify_____ No_____

7. Are you in favour of a price increase for the interest of curbing water wastage and abuse?
   Yes_____ No_____

8. During a water crisis, who is the responsible party? (Tick all those responsible)
   ☐ Government ☐ Water Authority ☐ Industry/Businesses ☐ The Public ☐ The Weather
   Others, specify_____

9. Does your family recycle water?
   Yes, specify_____ No_____

10. Your question: _____

11. Your question: _____

Example of a questionnaire in the school:

1. Are there any water saving devices in your school?
   Yes, specify_____ No_____

2. Do you know how much your school's water bill is?
   Yes, RM_____per month No idea_____

3. When you clean up after science, art or cooking class, do you turn off the faucet while you wash counters, dishes and equipment, and turn it back on to rinse?
   Yes_____ No_____

4. When you wash your hands, do you turn off the water while you soap?
   Yes_____ No_____

5. Does your school recycle water?
   Yes, specify_____ No_____

6. Are your school planted with trees, shrubs and grasses that are adapted to the climate so that they do not need extra water?
   Yes_____ No_____ Don't know_____

7. Is the flush valve on the toilets adjusted so that you use the least amount of water possible?
   Yes_____ No_____ Don't know_____

8. Does your school celebrate Water Day, Earth Day, or any other environmental celebrations?
   Yes, specify_____ No_____ Don't know_____

9. Your question:_____

10. Your question:_____

STEP 3: MAPPING YOUR WATERSHED

No water manager is worth his/her salt if he/she does not have a map of the watershed. To better understand and work on water problems, you should know where your sources of water originates from, how it is used, whether it is treated before being discharged, where it goes after you use it, and what drains, streams, rivers and lakes or coastal area drain or receive your waste waters in your watershed. A Watershed Map is imperative if you want to be a good water manager. It will help you plan your activities, locate your water problems, manage them and help you plan for the future.

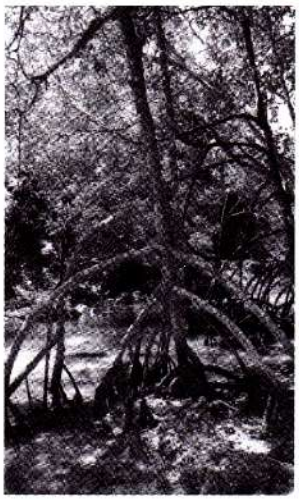
In Order To Map Your Watershed, All You Have To Do Is...

A. Collect the following materials:

- Any base map (preferably a topographical map) of your site and any other maps you have collected of the area.
- A sheet of tracing paper as large as your base map.
- A piece of cardboard as large as your base map.
- Thumb tacks.
- Dry erase markers and tissues.

B. Map your watershed:

- Place the tracing paper over the base map of your site and tack both onto the cardboard. If you don't have plastic, make a copy of the map and draw on it in pencil.
- On the base map, find and mark your site. A road map can help you find things.
- Locate the rivers, drains, wetlands, ponds and lakes, seas and other hydrological features in the vicinity of your site and mark them in blue on the map.



- Locate the upstream areas, i.e. areas with a lot of hills and contour lines. Now locate the sources of rivers, i.e. points where rivers start to flow. Locate the hill ridges, i.e. narrow areas along hill tops (often with elongated contours). From these ridges and hill tops, draw arrows on your map to show the flow of run-off. Draw a line along the ridges connecting all the hill tops, finally demarcating an area that completely surrounds your river, including its lowest point (the point where your river joins another larger river or empties into a lake or sea). You have now outlined your watershed. In what watershed is your site?

C. Now take your map to the highest point in your watershed. Look around you. Can you imagine where the rain water goes when it rains? Can you see the nearest river source? Can you see the nearest large water body (e.g. a lake)? Can you see other hydrological features such as swamps/wetlands, mining ponds, dams, reservoirs, canals, pipelines, etc. Can you also relate them to other physical and cultural features such as hills, valleys, flood plains, buildings, airports, schools, highways and roads, railway tracks or other features that are on the map? Mark all the features you can locate on your Watershed Map. Now try to find out which river, dam and water treatment plant provide your site with drinking water. Mark them on your map.

D. Now try to figure out where all the wastewater (water from bathrooms, toilets, kitchen, etc.) in your house goes. Your wastewater may be filtered through a septic tank or pump through underground pipes to a wastewater treatment plant. Try to locate where your wastewater goes and mark it on your map.

STEP 4: MEASURING YOUR SUCCESS

It is important to keep track of how much you have achieved, but how can you tell if you have succeeded? Is there an end point to indicate that you have indeed succeeded and that your project is finished? Is there such a thing as an end point in water conservation? How will you know whether you have made a difference and done a good job? The following guide can help you find the answers to these questions.

Measuring Your Success:

A. It is important to document your success so that your project gets noticed and replicated. Likewise, your failures should also be documented so that you (or others) can avoid making similar mistakes and improve your project. Other reasons for recording your success include the creation of greater water conservation awareness, water education, generate public support, donations, public co-operation, public help and resources. The most important reason is the ultimate aim of creating a "Water Saving Society". When you are successful, the mass media will be more likely to report on your work and this would go a long way to get more young people involved and join you. As for yourself, needless to say, there is great satisfaction to see what you have accomplished and to feel that you have made a difference.


2000年3月17日（星期五）

積水源監視協會22日辦

世界水源日推展活動

Recording Your Success:

- Count the number of maps you have drawn. Exhibit your watershed map. Have them photocopied and send them to everybody in your neighbourhood.

- Count the number of drains you have cleaned up, number of trees planted, kilograms of garbage removed from rivers, etc.

- Count the number of people involved directly in your group.

- Evaluate how much knowledge you have gained from the project.

- Count how many water experts you have talked to. How many man-hours did each person work on the project? How many total hours did your group work?

- Count how many people you and your group interviewed.

- Count the number of community leaders who came out to speak and support your project, whether in your neighbourhood or in your school.

- Count the number of litres of water saved in your home as a result of your action. Check your own water meter once a week and graph the amount of water used to see if you have managed to reduce your water demand.

- Count the number of litres of water saved in your school as a result of your action. Check your school's water meter once a week and graph the amount of water used to see if your school has managed to reduce your water demand.

- Count the number of litres of water saved in your neighbourhood (add all the houses involved) as a result of your action. Ask your neighbours to check their water meters once a week and graph the amount of water used to see if they have managed to reduce their water demands.

- Document your success through photographs or videos of your work. Organise a photography exhibition based on your work.

- Construct a website on the many free website hosting addresses available. This is a good way to let others know and replicate your work.

- Interview your headmaster, your teachers, fellow students and other water experts to get their views on your project. Document all their praises and show them to others. Get them to give you letters evaluating your project.

- Write stories, poems, songs, plays/ dramas, etc about your project.

- Give talks, tours or demonstrations to show people about your project.

STEP 5: CELEBRATING YOUR SUCCESS

Do not under-estimate your level of success. Celebrate your success, no matter how small it is! You have done all the hard work. Now is time to celebrate. So, how are you going to celebrate your success?

Ways Of Celebrating Water Success:

A. Be proud of your success and celebrate it. You have done a great job (voluntarily) for your school, community and family. Now, share what you have learned, your thoughts and visions, and most of all how you can help others replicate your project:

- What made you start on the project?
- Who was the most influential person who helped you all through your project?
- What was the most fun thing about your project? What was the least fun thing?
- What and who helped you the most? What and who were the biggest hindrance/s?
- How did you overcome the problems? Who helped you? What sort of help did you get?
- What have you learned about how people use and abuse water in the watershed?
- How do people's actions affect your water and that of others?
- In your opinion, what was your level of achievement in your project? Could you have achieved more? How?
- Has your work made a difference in how society view and use water? How?
- Did your work manage to change people's behaviour, especially in relation to water use?
- Given the chance, how would you do things in the future to improve on what you did?
- What advice would you give another group working on a similar project?

B. Celebrate your success! We all deserve some reward for a job well done. Celebration is fun and you need to work hard on planning and executing the celebration. Consider a celebration as part of your project - the ending part! A celebration is also a good way to say thank you to people who have helped and contributed to your project. Invite all those who have helped you to your celebration. Invite also newspaper or radio station reporters to your celebration so that they can publicise your story and your success. This will generate greater awareness on the importance of water issues. Here are some ideas on how you can celebrate your success:

- Organise a "Water Party" in your house/school and invite your friends, neighbours, teachers and relatives. At your party, do not just party away but

exhibit your project. Have water competitions and other water games but be careful not to waste water!

- Share your success with your local and national partners, and other NGOs.

- Invite newspaper and TV stations reporters to witness your celebrations and write on your success story.

- Write a story for the community newspaper. Weekly or monthly newspapers especially look for local stories.

- Print water souvenirs and T-shirts to publicise your objectives.

- Celebrate World Water Day on March 22nd each year. This can be done in collaboration with all your friends, NGOs, government departments, water companies, businesses, etc. Use your imagination. It's your celebration!!! (see below on how to celebrate.)

How To Celebrate World Water Day?

Locally

- Launching of new activities regarding water conservation and awareness.

- Drawing competition (theme on water conservation, importance of water, etc.)

- Photographic competitions of water resources.

- Campaigns.

- School programmes.

- Community projects such as camps and talks.

Nationally

- Hold water issues talks, seminars or conferences where everybody who is interested in water has a chance to contribute his/her ideas on how to improve things regarding water and exchange the ideas among themselves.

- A joint project between the government bodies, NGOs, private sectors and the community.

Internationally / Globally

- An international discussion regarding water issues, brainstorming and workshop.

- An advertisement on World Water Day, adding in the importance of water awareness, water conservation or anything that creates a society mindful of water.

- Global project helping poor countries in providing water, water awareness and water education.

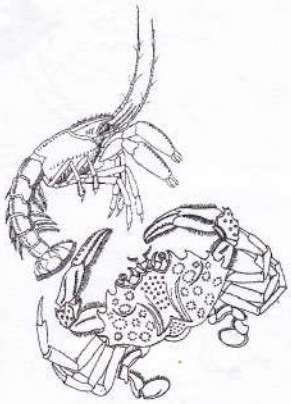
CHAPTER 4

MONITORING THE HEALTH OF YOUR WATER SOURCES

As a follow-up or ongoing project, you can monitor the health of your water sources. Contrary to popular myth, water quality monitoring need not involve high-tech instrumentation and expertise. Simple monitoring goes a long way to provide a general and acceptable indication of the health of our water sources. As soon as a water source is found to be "unclean", it can be reported to the authorities who will then follow up with more scientific testing. Choose a river and have your group make simple monitoring. If necessary, any ill-health of the water sources can be reported to the authorities immediately.

PHYSICAL CHARACTERISTICS OF WATER QUALITY

You do not need to be an expert to tell whether the water is clean or polluted in a river. By merely looking at the physical appearance of the water and the overall condition of the river (including plants and aquatic life), one can make a reasonable assessment of the physical well being of a river. Physical evaluation includes documentation of clarity of water, its colour, smell, general land use, description of the stream origin and type, summary of the riparian vegetation features, abundance of aquatic life (fish, prawns, etc) and measurements of in-stream parameters such as width, depth, flow and substrate.



The following table is a list of physical characteristics that can be used to decide whether a stream is clean or not.

Physical Characteristics	Clean	Moderate	Unclean/Polluted	Very Polluted
Water Clarity				
Water Colour				
Smell/Odour				
Abundance of Vegetation				
Abundance of Aquatic Life				
Flow Rate				
Algae				
Drains?				
Erosion?				
Garbage?				
Others				

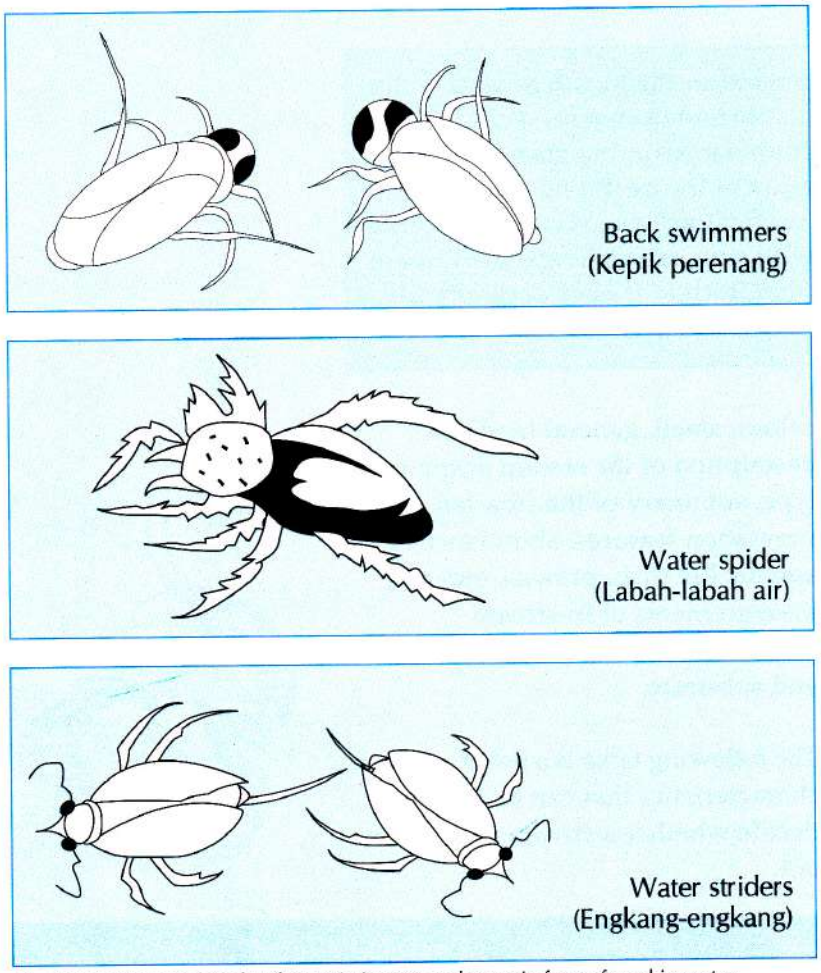


Diagram 8: Some example of aquatic insects and aquatic fauna found in water.

BIOLOGICAL CHARACTERISTICS OF RIVERS - THE USE OF AQUATIC INSECTS AS A BIO-INDICATOR

What are Aquatic Insects?

An aquatic insect is described as a three pair-legged organism that lives in and on water bodies such as rivers, lakes, ponds, swamps, etc. Some examples of aquatic insects are back swimmers, water spiders, water striders, water beetles, etc (Diagram 8). Aquatic insects can be classified as macro-invertebrates. Water quality is important to aquatic insects as they breed and live in water. Most larvae/nymphs of aquatic insects incubate, hatch and live in the water. Hence, water quality is crucial to aquatic insects as many have been found to be sensitive and cannot tolerate poor water quality. Because of this, sensitive aquatic insects can be used as "bio-indicators" of different levels of water quality.

We can use the presence of aquatic insects to estimate the water quality of a stream. Scientists have developed a tolerance ranking based on 5 groups of tolerance: (i) Very sensitive aquatic insects are those that can only be found in streams with good water quality; (ii) Sensitive aquatic insects are those that can only be found in streams with good or medium water quality; (iii) Moderately sensitive aquatic insects are those that can usually be found in streams with good or medium water quality but are also likely to be found in streams of poor water quality; (iv) Tolerant aquatic insects are those that can live in various degrees of water quality, and hence can be found across a range of water quality in streams, including in poor quality water; and

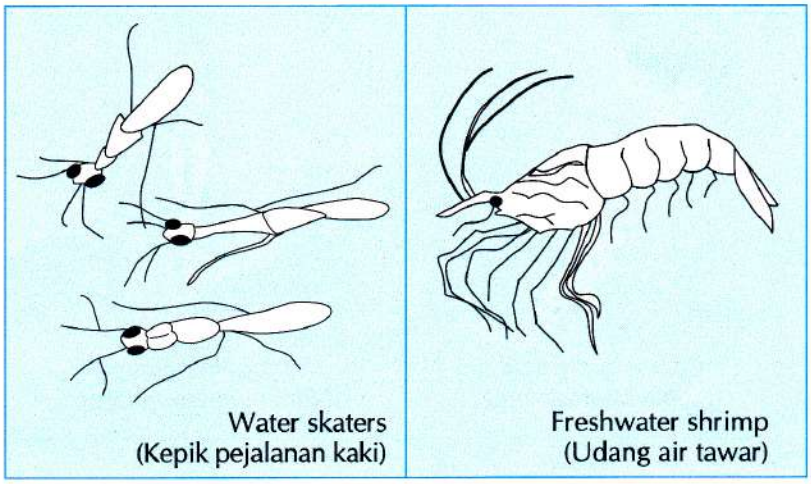
(v) Very tolerant aquatic insects are those that can be found in waters of very poor quality, and are usually the most abundant group in streams with poor water quality as they thrive in dirty waters.

(i) Very Sensitive Aquatic Insects and (ii) Sensitive Aquatic Insects

Generally, only a few aquatic insects fall under the Very Sensitive and Sensitive categories that require clean to very clean waters. If the water quality is not clean, they are usually absent. Some examples are:

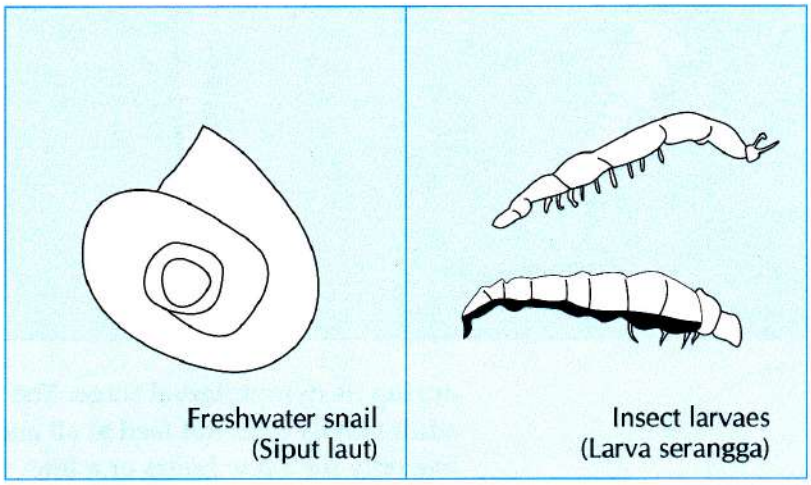
- The Stonefly - Possesses two 'tails' with long antennae and two pairs of wing pads. The stonefly is usually found among stones (hence stonefly) or aquatic plants in free-flowing and clean streams. Stoneflies feed on plants, animals or both that are usually found in clean waters.

- The Mayfly - Possesses three 'tails' with a short antennae. It has lateral gills along its abdomen. Like the stonefly it is also usually found under stones in fast flowing streams or among aquatic/riparian vegetation or leaves and twigs in slow flowing water. Unlike the stonefly which eats mostly live plants and insects, the mayfly feeds on algae and detritus (fine organic matter that is decomposed). Strangely, it feeds only



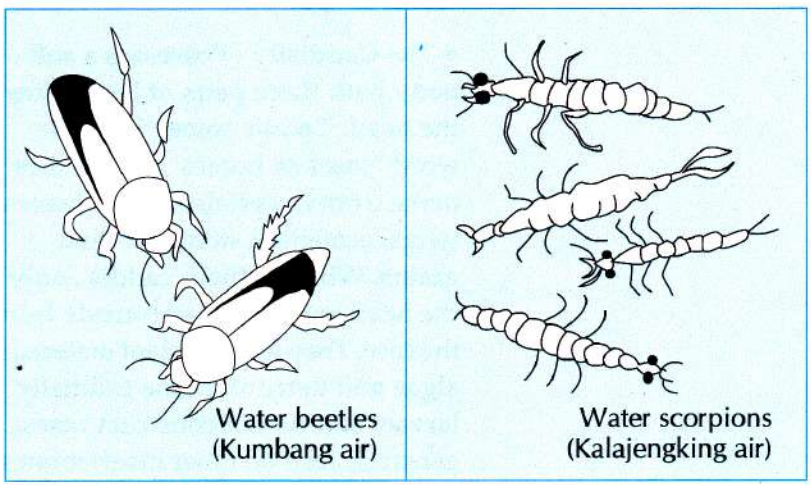
Water skaters
(Kepik pejalanan kaki)

Freshwater shrimp
(Udang air tawar)



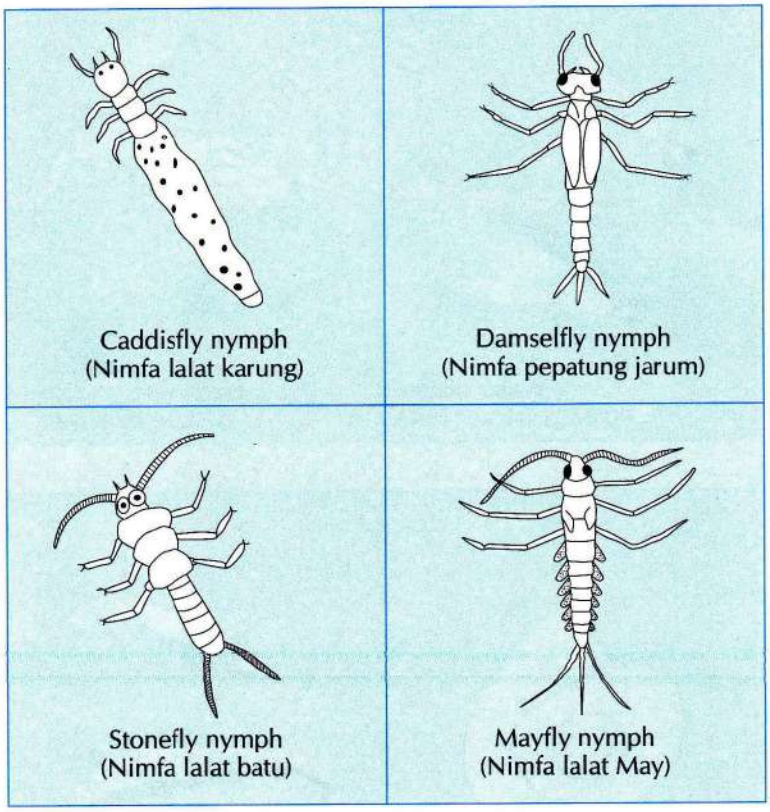
Freshwater snail
(Siput laut)

Insect larvaes
(Larva serangga)



Water beetles
(Kumbang air)

Water scorpions
(Kalajengking air)



during its nymph/larval stage. The adult mayfly does not feed at all and live only for a few hours or a few days at the most.

• The Caddisfly - Possesses a soft-body with three pairs of legs below the head. Caddis comes from the word "cases or homes", which they make from materials such as leaves, twigs, cemented stones or sand grains. While in their 'caddis', only the head and the legs protrude from the case. They feed on plant materials, algae and detritus. Some caddisfly larvae, that do not construct cases, generally feed on other invertebrates.

(iii) Moderately Sensitive Aquatic Insects

The dragonfly is a common insect found in streams in Malaysia. Other aquatic insects are the damselfly, the backswimmer, the water cricket, the water strider and water beetles. Most of these insects fall under the medium tolerance category and can be found in streams with moderate to poor water quality. Their biological description is given below:

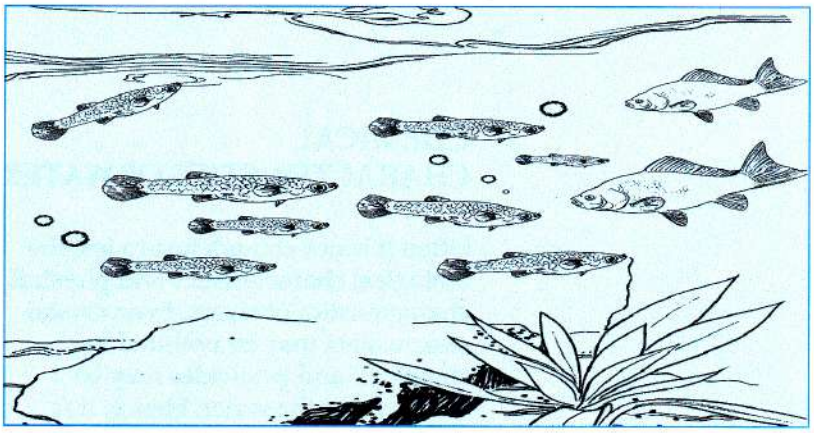
• Dragonfly and Damselfly - These insects have large bulging eyes with hinged grasping 'jaws' and slender legs. Both these insects are predators. The difference between the two is: when at rest, adult dragonflies open out their wings horizontally (like an aeroplane) while damselflies fold their wings together pointing vertically up.

• Water Bugs such as Back Swimmers, Water Crickets and Water Striders - These insects are like mosquitoes as they have needle-like mouthparts, which are used for piercing their prey and extracting body juices. These insects can be found among aquatic plants, on the water surface or swimming through slow flowing or still water. Many common river insects such as water boatman and water scorpion also fall under this category.

• Water Beetles - These insects are hard, oval or flattened round shaped (water pennies) and smooth. They are attractive as many are multi-coloured. Water beetles possess piercing jaws and their larvae are usually elongated and slender. Water beetles have a voracious appetite and are great predators. Some water beetles such as the "diving beetles" and "water scavengers" often possess an air chamber, i.e. a silvery layer of air across the under surface of the body to enable it to slide through the water. Some like the whirling beetles have feathery gills on the sides of the abdomen.

(iv) Tolerant Aquatic Insects and
(v) Very Tolerant Aquatic Insects

Tolerant aquatic insects are usually macroinvertebrate fauna consisted mostly of pollution-tolerant midge larvae and worms, indicating poor to fair water quality. The most common form of tolerant and very tolerant group of insects is the midge larva or Chironomid larva (from the family of Chironomidae). The midge larva is slender, worm-like and has a pair of short fleshy legs below the head and another pair at the tail end. It can grow up to 15 mm long and its colour is usually white, green or red. Red Chironomids are referred to as 'bloodworms'. They tolerate poor water quality as they thrive in waters with very low oxygen levels.



Fish As Bio-indicator

One does not need to be a scientist to tell whether a stream is clean or not in terms of fish. Generally, when fish is abundant, the water is clean and unpolluted. However, different fish species can reflect water quality. For example, the Chinese carp is usually found in clean rivers while the common catfish, tilapia and guppy are associated with dirty waters and are often found in abundance in polluted drains. Other than fish species as a bio-indicator of water pollution, the fish reaction to changes in its environment is also important. For example, indicators such as growth and/or increased population density, modified activity, reduced growth, a decline in population, and "fish kill" are all indicators of water quality. Depending on their degree of complexity, size, generation time and other factors, organisms and different species react at varying rates.
Generally, fish are good indicators of long-term (several years) effects and broad habitat conditions because they are relatively long-lived and mobile.

CHEMICAL CHARACTERISTICS OF WATER

Often it is not enough just to test the biological characteristics and physical characteristics of rivers. Even crystal clear waters may be polluted as chemicals and pesticides may be dissolved in the water. Hence, it is necessary to test the chemical characteristics of water as well. The uptake of toxic substances, such as heavy metals and organochlorine compounds, causes various kinds of deformities of the larval and pupal Chironomidae in aquatic insects. Similarly, frogs and insects can also be deformed when absorbing pesticides from polluted waters.

pH

Water can either be alkaline, neutral or acidic. Hence, pH is a term used to indicate the alkalinity or acidity of water and is ranked on a scale from pH 1.0 to pH 14.0. When the pH is 7.0, the water is termed neutral. Acidity increases, as the pH gets lower. Diagram 9 represents the pH of some common liquids. pH is an important indicator of water quality as pH levels less than 4.0 will effectively kill most aquatic fauna in rivers. Hence, acid rain and dry acid deposition can be very dangerous for rivers and lakes. In addition, pH also affects many chemical and biological processes in the water. For example, different organisms flourish within different ranges of pH. The largest variety of aquatic animals prefers a range of 6.5-8.0. pH outside this range reduces the diversity in the stream because it stresses the physiological systems of most organisms and can reduce reproduction. Low pH can also allow toxic elements and compounds to become mobile and "available" for uptake by aquatic plants and animals. This can produce conditions that are toxic to aquatic life, particularly to sensitive species like fish and shrimps. You can use a pH meter to measure river pH. Your school's science laboratory should have pH meters or pH paper strips. Check with your science teacher.

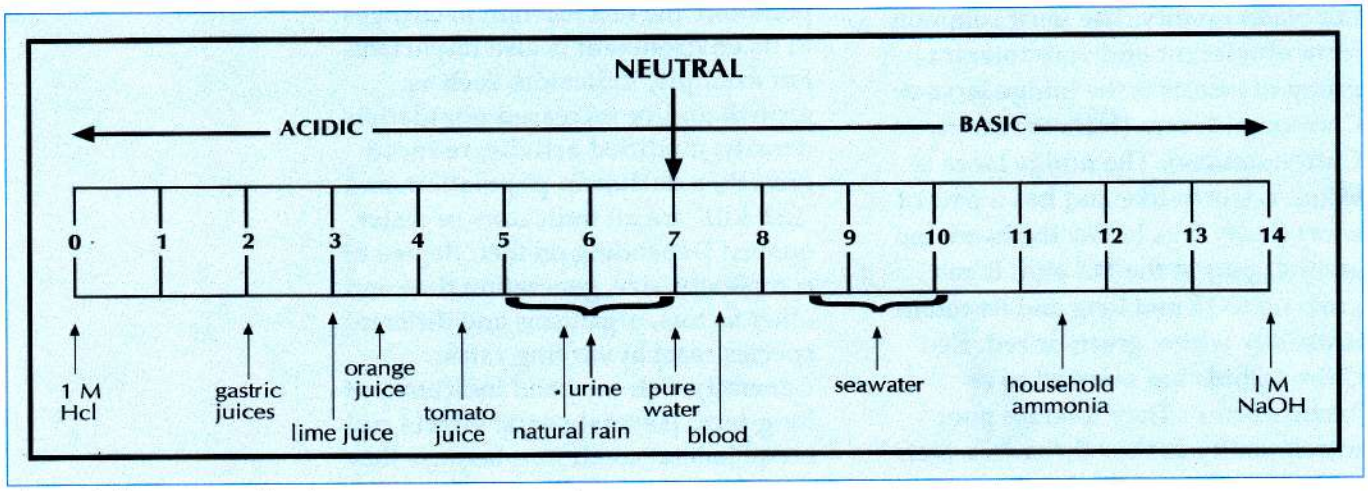


Diagram 9: The common pH scale.

Dissolved Oxygen

Like our atmosphere, water contains oxygen in a dissolved form. However, the river system produces as well as consumes oxygen. When a river cascades down rapids and waterfalls, or dissolves oxygen from the air, it gains oxygen from the atmosphere (and from aquatic plants via photosynthesis). When water is flowing or running, it churns and dissolves oxygen from the air. Hence, moving waters are rich in oxygen as compared to still waters in ponds, swamps, reservoirs or dams. However, some processes such as eutrophication (algae consuming oxygen in ponds making the water deficient in oxygen), respiration by aquatic animals, decomposition and various chemical reactions consume and deplete oxygen in water bodies. In addition, wastewater from our houses and sewage treatment plants often contains organic materials that are decomposed by microorganisms, which consume oxygen in the process. The Biological Oxygen Demand or BOD is a measure of water pollution as it measures the amount of oxygen consumed by these organisms in breaking down the waste (the higher the BOD, the greater the pollution). As an exercise, you can measure the oxygen level in your stream as its dissolved form or dissolved oxygen (DO). This is done with a dissolved oxygen meter. When the DO is high, water quality is good and vice versa. When more oxygen is consumed than is produced, DO levels decline and some sensitive aquatic insects and fauna may migrate, weaken or die.

Conductivity

Another simple measurement that tells you about your stream water quality is its conductivity. As in physics, the conductivity of water is a measure of the ability of water to pass an electrical current. As the conductivity in water is affected by the presence of inorganic dissolved solids such as phosphate, chloride, nitrate, sulfate and other anions (ions that carry a negative charge) or sodium, magnesium, calcium, iron and aluminium cations (ions that carry a positive charge), the conductivity will change according to the concentrations of these elements. Hence, conductivity measures chemicals that are dissolved in the water. However, one should be careful as conductivity is also affected by temperature: the warmer the water, the higher the conductivity. For this reason, conductivity is reported as conductivity at 25 degrees Celsius (25 °C). Conductivity in streams and rivers can be affected by the geology of the area through which the water flows, granite bedrocks having lower conductivity (as granite is composed of more inert materials that do not ionize or dissolve into ionic

components) while clay soils having higher conductivity (clay possesses materials that ionize when washed into the water). Of course, discharges containing pollutants also affect the conductivity. For example, untreated sewage washing into rivers would raise its conductivity (due to the presence of chloride, phosphate and nitrate). High levels of conductivity can kill species of fish or macroinvertebrates. You can use a conductivity meter to measure conductivity.

Temperature

Temperature is measured by a temperature meter. Often, a pH, DO or conductivity meter has a temperature probe that measures temperature as well. Rivers that have cool waters tend to be better for aquatic fauna as compared to those with warm/hot waters. Hot waters coming from industrial effluents can often give rise to fish kills. In addition, the rates of biological and chemical processes depend on temperature. Aquatic organisms from microbes to fish have different levels of tolerance of water temperature. Hence, optimal temperatures for fish depend on the species as some survive best in colder water, while others prefer warmer water. Benthic macroinvertebrates are also sensitive to temperature and will move in the stream to find their optimal temperature. When temperatures fall outside their optimal range for a prolonged period of time, organisms are stressed and can die. In Malaysian rivers, optimal temperatures, measured in degrees Celsius (° C) are usually between 18 - 24 ° C.

Total Suspended Solids (TSS) and Turbidity

Total suspended solids (TSS) refer to the amount of matter (organic and mineral) that is not dissolved but suspended in the water. The higher the concentration, the more polluted the water. Hence, higher TSS concentrations result in higher turbidity. TSS and turbidity therefore measure the same thing as both indicate the amount of solids suspended in the water, whether mineral (such as soil or salt particles) or organic (such as fine leave sediments, algae, humus, etc). TSS test can be done by taking a sample of water (e.g. 50 mℓ) and filtering it through a paper filter. The amount of suspended matter remains on the filter and can be weighed after drying the filter. It is measured in miligrams per litre (mg/ℓ). The TSS test actually measures an actual weight of material per volume of water, while turbidity measures the amount of light

scattered from a sample (more suspended particles cause greater scattering). When attempting to calculate total quantities of material entering a stream, one has to use the TSS test but not the turbidity readings. Usually, high concentrations of suspended matter can cause increased sedimentation and siltation in a stream, which in turn can pollute aquatic habitat and spawning areas for fish and other aquatic life. In addition, suspended particles also provide attachment places for other pollutants, such as metals and bacteria, and high TSS readings can be used as "indicators" of other potential pollutants.

Total Dissolve Solids

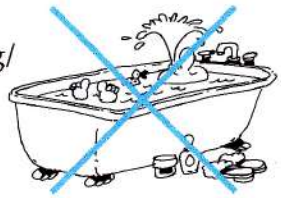
Contrary to suspended solids that are not dissolved but suspended (and can be seen), total dissolved solids (TDS) cannot be seen as solids, are dissolved in the water. Hence, even crystal clear water may be polluted by chemicals. TDS in rivers consist of dissolved solids of calcium, chlorides, nitrate, phosphorus, iron, sulfur and other ions particles that will pass through a filter with pores of around 2 microns (0.002 cm) in size. The concentration of total dissolved solids can adversely affect aquatic organisms if the dissolved solids are heavy metals and other dangerous chemicals. It can also affect the water balance in the cells of aquatic organisms. On the other hand, water with little or no dissolved solids can be equally dangerous for aquatic life. For example, an organism placed in distilled water (consisting of very low levels of dissolved solids) will swell up because water will tend to move into its cells, which have a higher concentration of solids. Conversely, an organism placed in water with a high concentration of solids will shrink somewhat because the water in its cells will tend to move out. This will result in the organism having difficulty in maintaining its position in the water (i.e. it will float up or sink down to a depth to which it is not well adapted, hence killing it). Turbidity can be measured by a turbidity tube. Fill a glass/plastic tube with water and put a coin at the bottom. Fill it with water and see how deep is the column of water up to the point when you can no longer see the coin.

CHAPTER 5

21 THINGS YOU CAN DO TO HELP CONSERVE WATER IN THE 21ST CENTURY

SIMPLE STEPS TO CONSERVE WATER IN THE 21ST CENTURY

1. **Shower**
   Reduce number of showers; Off shower when soaping/ shampooing; Do not over-use soap/shampoo; Use "organic-based/environmentally-friendly" soap/ shampoo; Do not put on the shower at full blast; Cut short shower time.



2. **Brushing Teeth**
   Use a cup instead of a running tap.

3. **Washing Face**
   Use a wet towel instead of a running tap.

4. **Hair Style**
   Short hair definitely requires less water to wash and clean.

5. **Toilet Use**
   Use the squatting toilet for short calls; Install a "dual flush" mechanism; Put a brick in the cistern.

6. **Washing Car**
   Reduce car washes; Use a bucket/pail instead of a hose; Use rainwater/reclaimed water/well water for car washes.

7. **Recycling Water**
   Collect water used for washing hands, vegetables and rinsing dishes for watering plants or for flushing the toilet; Do a minor pipe connection to collect greywater from upstairs for non-consumptive re-use.

8. **Rainwater Harvesting**
   Collect rainwater for non-consumptive use.

9. **Stay Home More**
   Reduce going out. Spend more time with the family.

10 Watering Plants/Gardening
Use recycled water; Use a pail instead of the hose; Water sparingly (near roots); Put a plate under each flower pot to retain water from leaking out of the pots. Use drought-tolerant plants for landscaping.

11. Cleaning Floors
Use a mop and pail instead of a hose; Use "no-rinse" washing liquid; Sweep the floor more often to reduce the need for mopping.

12. Washing Pots/Pans and Crockery
Use biodegradable no-rinse washing liquid; Wash with two sinks - one for soaping and the other for rinsing; Never use a "dishwasher".

13. Cooking
Reduce oily food and take more steamed and fresh food.

14. Clothing
Wear cotton/light clothes (Less to wash); Pants and some clothes can be worn twice before washing.

15. Washing Clothes
Wash only when there is full load; Use environmentally friendly washing powder; Collect effluent water from washing machine for re-use; For handwashing, use a pail instead of running tap.

16. River Water Use
If you live near a river, use river water for non-consumptive purposes.

17. Well Water
If you have a well, use its water for non-consumptive purposes.

18. Remind/Teach/Advise/Enlighten Others At Home, Work Place, Neighbourhood and Anywhere Else on Water Saving

19. Low-flow Taps and Shower-heads
Switching to low-flow shower heads and faucets saves 50 % of water used.

20. Behavioural Changes
Simple behaviour changes such as filling a sink with water rather than leaving the water running can save a lot of water.

21. Report Leakage, Damage, Water Thefts, Etc Immediately:
PBA 1-800-888100/ 8280049 or 509-6-509; Water Watch Penang 2283306 or 012-5193355

APPENDIX 1

ESSENTIALS OF WATER

• Water's chemical formula is H^2O - one atom of oxygen bound to two atoms of hydrogen. The hydrogen atoms are "attached" to one side of the oxygen atom, resulting in a water molecule having a positive charge (on the hydrogen atoms) and a negative charge (on the oxygen atom). Since opposite electrical charges attract, the hydrogen and oxygen molecules attract each other (like a magnet), and get "stuck" to each other.

• Water is the most unique element on earth - it is the only natural substance that is found in all three states – liquid (water), solid (ice or snow), and gas (vapour or steam) at the temperatures normally found on earth. As a result of changing weather, water is constantly changing from one form to another.

• Water freezes at 0 degree Celcius (°C) and boils at 100 °C (at sea level). Hence, water's freezing and boiling points are the baseline with which temperature is measured: 0 °C being water's freezing point and 100 °C being its boiling point.

• Water boils quicker at the peak of Cameron Highlands than at the Batu Ferringhi beach. This is true as the boiling point of water gets lower when the altitude gets higher. At the beach (0 metre), water boils at 100 °C but in Cameron Highlands (1,500 metres), water boils at 94.9 °C. Further up at 3,280 metres, water will boil at 89.8 °C. This is because as the altitude gets higher, the air pressure becomes less. Since there is less pressure exerted on the boiling water surface at a higher altitude, it is easier for the water molecules to break their bonds and attraction to each other and, thus, it boils more easily.

• Water has unusual properties in that the solid form, ice, is less dense than the liquid form, which is why ice floats. However, when water freezes (i.e. changes from liquid to solid), its volume expands about 10%. In nature, this expansion is an important form of weathering (i.e. breaking down of rocks into soil). Be careful not to leave a can of cola in the freezer because when it freezes, it will burst and mess up your freezer.

• Water has a sticky and elastic property, and tends to clump together in drops rather than spread out in a thin film. This is because water has a very high surface tension. This surface tension is responsible for capillary action whereby water (containing dissolved nutrients) move through soils, through the roots of plants and through the tiny blood vessels in our bodies.

• Water is known as the "universal solvent" because it dissolves most things, i.e. more substances than any other liquid. Because of this quality, wherever water goes, either in rivers, in the ground, in trees or animals, or in our bodies, water takes along valuable chemicals, minerals and nutrients. So, when we drink water, all these nutrients are passed into our bodies. Conversely, if the water we drink is polluted or poisoned, the pollutants and poisons will get into our bodies. Hence, the importance of protecting our waters.

• Hardness measures the amount of dissolved calcium and magnesium in water. Water hardness varies depending on the rocks in an area. If you live in an area where the water is "soft", then you may never have even heard of water hardness. But, if you soap your hands in hard water (e.g. water from limestone caves in Batu Caves), you will notice that it is difficult to get a lather up. This implies that industries using hard water will have to spend a great deal of money to soften their water, as hard water can damage equipment. Hard water can even shorten the life of fabrics and clothes!

• Dissolved oxygen, the amount of oxygen dissolved in the water is needed by aquatic organisms for breathing and to live. Moving water in rivers mixes oxygen (in contact with top layer of water) into the water. However, stagnant water

such as a pond contains little oxygen. Aquatic organisms will find it difficult to survive in stagnant water that has excessive rotting, organic material as dissolved-oxygen levels will be deficient.

• In Malaysia, the most common pollutant affecting our rivers is suspended sediment or the amount of soil/silt/mud suspended in a river. During thunderstorms, a lot of soil (especially in logging and exposed areas) is washed into rivers, resulting in the characteristic "Teh Tarik" colour of many of our rivers. If we have dense forest or vegetation cover, it will reduce the amount of suspended sediments getting into our rivers.

• When moist air (containing water vapour) is forced upwards, it will start to cool and the vapour condenses into liquid droplets, and a cloud will form. This process is responsible for the formation of our different types of clouds. Rising air always cools because higher elevations are cooler. The liquid droplets in clouds are initially too fine to drop out of the cloud as rain. However, mixing of droplets (which causes them to combine) and the attraction between liquid and ice droplets (also causes them to combine) will gradually form large droplets. This process will eventually form large enough droplets to fall out of clouds as rain, hail (ice droplets) or snow.

• Crystalization is the process whereby evaporation of all the water in a substance leaves the remainder as a crystal or solid. For example, if you heat a glass full of sea water with a 20 % salt concentration, evaporation of all its liquid will leave a 1 inch layer of salt. Hence, about one-fifth of the total volume of the water comes from salt or 1/5 of the water is made up of dissolved salt.

• Rain in many parts of Malaysia is slightly acidic. In industrial and urban areas such as Prai, Kuala Lumpur, Petaling Jaya, Shah Alam and Johor Baru, the rainfall is acidic between pH 4.5 to 5.0. The inland forested areas have rains with pH between 6.0 to 6.5. This shows that industrialization and urbanization are two processes that contribute to the exacerbation of acid rain.

• It is a common misconception that raindrops are tear-shaped like this  although when a drop of water comes out of a tap, it does have a tear shape. In the case of the tap, the tear shape is due to the back end of the water drop sticking to the water still in the tap until it can't hold on any more and drops out. However, rain drops are not in contact with other drops and do not have tear shapes. Experiments using high-speed cameras show that falling raindrops are round-shaped and look more like small kaya buns of bread! Gravity and surface tension causes the falling rain drop flatten out somewhat. The strong surface tension of water holds the drop together, resulting in a bun shape  .

• In much of the developed world, drinking "toilet water" is very real as a significant amount of wastewater (water from bathroom, kitchen and toilets) are recycled for drinking.

• Many countries in the world such as Yemen, Libya, Saudi Arabia, Jordan, Syria,Tunisia and Egypt are living below the "Stress Line" for water, i.e. having a per capita renewable water of less than 1,700 cubic metres of water per person per year. Malaysians are very lucky because our per capita renewable water is more than 20,000 cubic metres of water per person per year. Still, we have water crises and droughts! This reminds us that we need to conserve our water, stop wastage and use water wisely.

• The number of dams and treatment plants that can be built is limited, because a river and its basin has limits. However, population has no limits as population continues to explode. Many river basins in Malaysia have reached their limits of maximum supply (25 river basins). Yet water demand "doubles" every 2 decades but supply lags far behind. In 2007, Selangor is estimated to experience water stress. In 2010, Penang is expected to have insufficient water.

APPENDIX II

MEMBERSHIP APPLICATION FORM
(BORANG PEMOHONAN KEAHLIAN)

Name/*Nama*: _____

Address/*Alamat*: _____

_____

Tel: (Home/*Rumah*)_____ (Office/*Pejabat*) _____

Fax/*Fak*: _____ Email/*Emel*: _____

Occupation/*Pekerjaan*:_____

Signature/*Tandatangan*: _____ Date/*Tarikh*:_____

Category Of Membership	Admission & Subscription
Life Member/*Ahli Seumur Hidup*	RM500.00 Admission Fee (No Annual Subscription)
Ordinary Member/*Ahli Biasa*	RM10.00 Admission Fee RM12.00 Annual Subscription
Donation/*Sumbangan*	RM
Cheque/Money Order for the amount of payable to **Water Watch Penang** is enclosed	RM

Please mail form and payment to:
Sila kirimkan borang dan bayaran kepada:

The Honorary Treasurer
Water Watch Penang
10 Brown Road
10350 Penang
Malaysia

Water Watch Penang
Persatuan Pengamatan Air Pulau Pinang

POEM

Aquarian Connection

Words or tongue
do not matter:
Voda or Wada
Maji or Pani
Agua or Wasser -
this is the glue
that holds
all Life together.

It has neither
shape, taste
colour or odour
but an awesome
power to break
batter, devastate
deluge & destroy;
yet power too
to resuscitate
sustain, heal
cleanse, create
bless & revive .....
not so much
essence of life
as Life itself.

In water conceived
nurtured, nourished
we, no more
than walking
sacks of water,
too often take
this boon for granted
wobble towards disaster.

From water we came
(several millennia ago)
with water now we flow
our liquid lives
so intertwined
that
when
water
goes .....
we GO!!

This poem by Cecil Rajendra was written specially for the World Water Forum, Osaka, Japan 2003. Cecil is among the leading poets of the third world and lives in Penang, Malaysia.

About Water Watch Penang

OBJECTIVES

Persatuan Pengamatan Air Pulau Pinang or Water Watch Penang is a voluntary, non-profit citizens' organisation set up to promote the study, awareness and knowledge of water monitoring, conservation and protection, and the practice of a water-saving society. It aims at achieving the sustainable development of water resources in accordance with the aspirations of Agenda 21 of the Earth Summit and Malaysia's Environmental Commitment.

ACTIVITIES

In pursuance of these principles Water Watch Penang has been established to:

1. publish and distribute articles, pamphlets, journals, periodicals and books
2. promote public awareness by organising field trips, educational camps, seminars, forums, conferences, lectures and talks
3. conduct research
4. liaise with other societies dedicated to similar aims and objectives
5. provide a link between government, water companies, NGOs and the public

COMMITTEE

Water Watch Penang is a fully registered society under the Societies Act.

SECRETARIAT

The Secretariat for Water Watch Penang is the Socio-Economic & Environmental Research Institute (SERI). SERI is also acting as the Secretariat for Water Watch Asia, which is based in Penang.

BENEFITS TO YOU AND THE ORGANISATION

You can take part in all our activities. Membership fees will keep us going. You can help create greater awareness towards the conservation of our water resources. A large membership and active communal/ citizen participation will help convince the authorities that the public can play an active role in water conservation.

For further information, contact
Water Watch Penang
c/o Socio-Economic & Environmental Research Institute
10 Brown Road, 10350 Penang, Malaysia
Tel: **6-04-2283306** Fax: **6-04-2267042**
Email: **seripg@tm.net.my**

Prof. Dr Chan Ngai Weng, President
Tel: **6-04-6533888** ext. **3829**
H/P: **6-012-5193355**
Email: **nwchan@usm.my**

WWP's Homepage: http://**surf.to/waterwatchpenang**

SERI's Homepage: http://**www.seri.com.my/**

Water Watch Penang

Persatuan Pengamatan Air Pulau Pinang

Protecting, Saving and Conserving Our Water Resources for Future Generations - Towards Sustainable Development