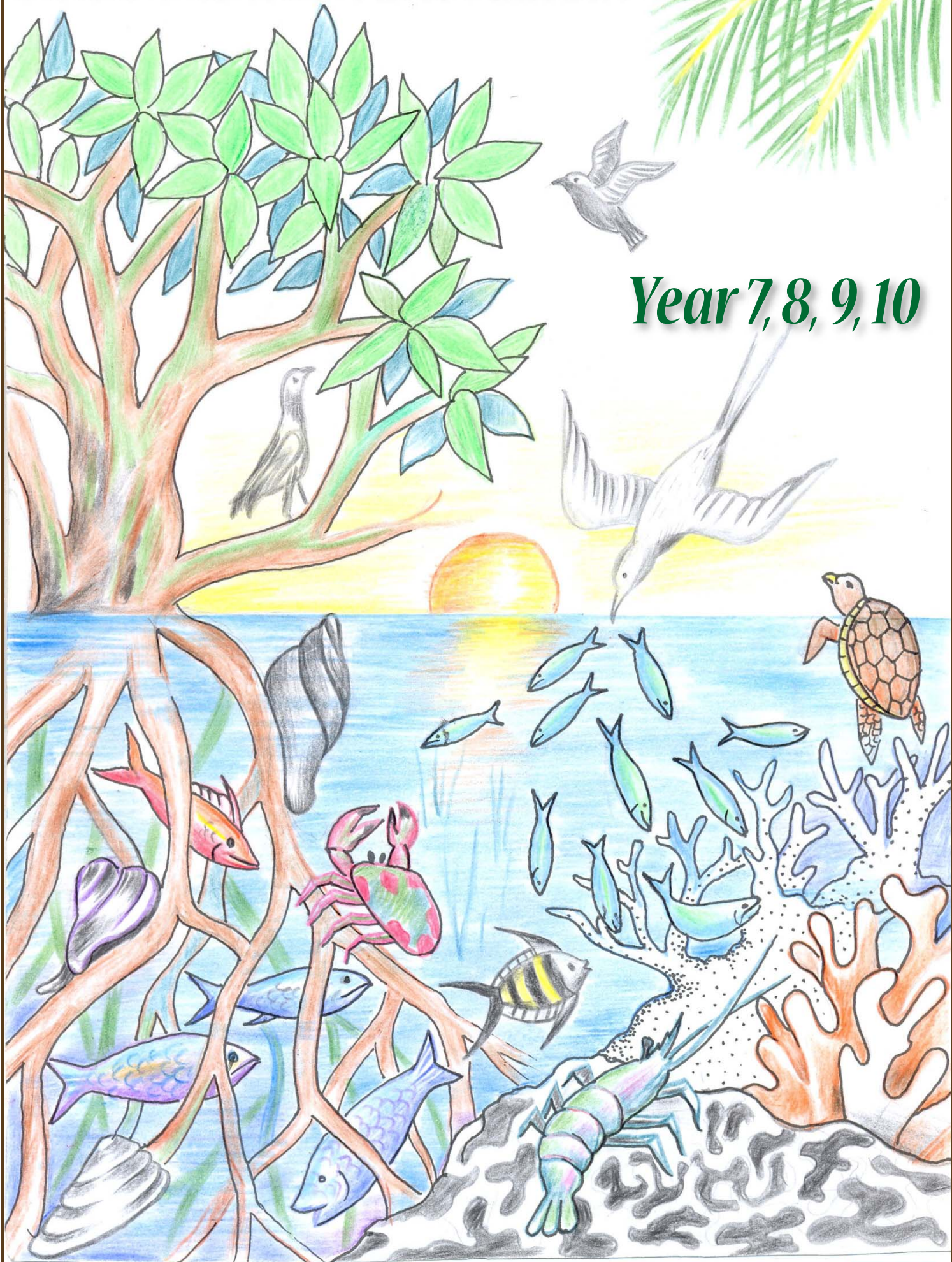


# Environment Resource Education Guide

Year 7, 8, 9, 10



MNRE  
MESC

Our Environment Our Heritage



EU



# **ENVIRONMENT RESOURCE EDUCATION GUIDE YEARS 7 - 10**

- Mangroves
- Waste management
- Biodiversity
- Marine ecosystem
- Water resources
- Climate change

**Compiled by:**

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Mr. Poutoa Leituvae.

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## FOREWORD

The history of the Environment Resource Education Guide goes back to 1999 when it was first developed as the *Coastal Marine Resource Education Kit*. It was a joint initiative developed under the Department of Lands, Survey & Environment at the time, Department of Education, Department of Agriculture through the Fisheries Division and SPREP. The focus was: ( 1 ) to help promote understanding of coastal marine resources; ( 2 ) to assist interested organizations with their involvement in Environment Education by providing information materials on environmental issues; and ( 3 ) to enhance public awareness efforts in schools.

The Coastal Marine Resource Kit project was initiated as a component of a larger initiative in capacity development funded by UNDP under the Capacity Building for Environmental Management in the Pacific (CBEMP) Project which provided technical assistance on database and information materials for environmental awareness. The Resource Kit was initiated to encourage the integration of existing resource materials in line with the Department of Education National Curriculum to help the students better understand the interconnection of marine resources and livelihood, human impacts and encouraging greater interchange between environment and education.

In 2005 the Ministry of Natural Resources & Environment in collaboration with the Ministry of Education, Sports & Culture revised the Resource Kit with a more holistic approach to environment education. Whilst the focus of the Coastal Marine Resource Education Kit was mainly on marine resources, the revised Environment Resource Education Guide was expanded to incorporate other key environmental aspects in the six thematic areas of: *Marine Ecosystem, Biodiversity, Water Resources, Waste Management, Climate Change and Mangroves*. In recognition of the various environmental concerns affecting small island states like Samoa, it was important to provide a Resource Guide that could help enrich and strengthen the children's knowledge base on environmental issues affecting small island states.

Thus Environment Resource Education Guide for Years 7 to 10 aims to support the implementation of environment education initiatives in our schools. It is a compilation of instructional resource materials developed to enhance general understanding, information sharing and learning at the primary and secondary levels. It is a unique project with a notable level of partnerships and strong cooperation among interested agencies to promote the use of environment education to foster the values, behaviour and lifestyles required of our young generation for a sustainable future.

A key focus of this Environment Resource Guide is the need to integrate environment education for sustainable development' (ESD) into the national curricula which promotes learning to empower our young generation to take on



responsibilities for creating a sustainable future. Thus reflected in our vision ... "Our Environment Our Heritage".

Environment education is all about building the knowledge base of the young generation to become stewards for the environment and to encourage their active participation in resource management. It's about using education as the primary agent of change towards sustainable development and nurturing their capacities and transforming their visions for society and the world. We hope this Environment Resource Education Guide will enhance our young students' awareness and understanding of the environment, as they will be its caretakers for the future.

We acknowledge with appreciation the assistance from the European Union Water Sector Support Programme for supporting this project. The compilation of the Resource Guide was made possible with funding from the European Union and without which, this important initiative would not have materialized. We value the support in recognition of committed partnerships towards conserving our future environment. We also acknowledge with sincere gratitude the commitment and contributions from members of the Education Guide Task Team for their contributions ensuring we achieve this milestone. Our consultant Ms Masa Faasau has demonstrated her genuine passion for the environment with this remarkable package ... Malo le Tauata'i!

The Resource Guide is produced in a "folder" for practical use by teachers. It is also intended that we will all continue to update this package regularly as more information are available in the future every year. For that we welcome ideas and suggestions from all parties who are involved with the propagation of environment education in Samoa.



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I would also like to acknowledge the sources of references, from which I have gathered some activities, adapted and further developed to suit the local curriculum. I have also quoted your expertise in the various fact sheets and used your illustrations and ideas to suit the purpose of this Resource Guide. Your details are in the Bibliography Section.

## **MESSAGE TO THE TEACHER**

1. Activities are designed to develop skills in:
  - communication;
  - critical thinking;
  - exchanging ideas;
  - social development;
  - creative capability;
  - environmental awareness; and
  - dialogue and decision-making.
  
2. Activities for the different levels can also be used across subject areas such as English, Mathematics, Social Science, Agricultural Science, Science, Art, etc. Some of the activities are adapted from various sources acknowledged in the guide. You do not need to do all of the activities, it is left up to the individual teacher to select only ones that are suitable and appropriate for their particular classes.
  
3. Fact sheets for each topic are provided to assist teachers in carrying out activities and lessons. There are four Fact Sheets for each topic that can be used across the four levels. They can also be used by students as extra information and to assist in investigations. All Fact Sheets are from publications by specialists in the various areas and the sources are acknowledged.
  
4. For all activities that require field trips, please remember you are responsible for the following:
  - Setting a date.
  - Asking permission from the Principal, parents & guardians and the people at the field trip site.
  - Setting the time. If you are going to the mangroves or the coral reef, then make sure it is low tide. You will need tide information available from the Meteorology Office, radio or TV stations.
  - Organise transport and how it will be paid.
  - Prepare field trip notice for parents' approval, including materials needed for the trip, time of trip and time returning, cost of trip, and students' food and clothing.
  - Organise extra helpers to supervise students – other teachers, parents, and school committee members.
  - Prepare a first aid kit.
  - Organise equipment and other resources needed for the trip.
  - Make sure students are well informed of the purpose of the field trip and to have respect for all living things at the site:
    - (i) look before disturbing;
    - (ii) return all plants and animals to their habitats after observing them;
    - (iii) replace any rocks which have been moved or turned over; and

- (iv) make sure the students are aware of the dangers of rising tide and poisonous animals
5. For all activities that require Guest Speakers, the teacher is also responsible for the following;
    - Ask permission from Principal for the activity.
    - Organise with specialist the time, date of activity and what precisely it is that is expected of the speaker. That is, the topic and the information that needs to be relayed to the students. Teacher will need to write a formal letter and speak personally with guest.
    - Prepare students for the activity by giving background information and what they are expected to do during the presentation. Also select a student to say words of thanks and appreciation after presentations.
  6. The Topics Guide section gives the objectives and learning outcomes for each activity, a brief description of the activity, where it is related to the curriculum, skills achieved and used in the activities and assessment.
  7. Materials needed for activities are listed in the activity sheets and suggested time needed. Length of class periods may vary from school to school and teachers are advised to change time according to their needs.
  8. Teachers are encouraged to add to the activities or adapt them to suit the availability of resources and class/students' level.
  9. Many of the activities require students to produce resource materials, so be prepared for a lot of resources and beautiful decorations for your classroom!

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• Live & Learn Environmental Education. **HOPE Teachers' Guide**. 2006

#### IV. TOPICS GUIDE CHART

##### MANGROVES

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
7	To introduce students to locations of mangrove areas in Samoa.	<ul style="list-style-type: none"> <li>- mark &amp; locate villages on map</li> <li>- state why mangroves are found in particular areas</li> </ul>	Where are the mangroves? - map work in classroom about mangrove areas in Samoa.	Social Science – map work, natural resource, forests. Science – conservation, community study. Year 7 Science Book, Unit 2, pgs. 4 – 6. <b>Assessment:</b> Correct maps drawn in books.	Group work, mapping, drawing, stimulates attention & concentration knowledge of local environment, names of villages
7	To introduce students to simple fieldwork studying the mangrove community.	<ul style="list-style-type: none"> <li>- name and identify organisms found in the mangroves</li> <li>- name two uses of mangroves</li> <li>- draw and label leaves, roots, stem, flower, seed</li> <li>- state the functions of the parts</li> <li>- state features of mangroves</li> <li>- state why mangroves are important</li> <li>- label the parts of a mangrove plant</li> </ul>	The Mangroves: <u>Part A</u> – Mangrove Walk - field trip to look at plants & organisms in mangroves. <u>Part B</u> – Colouring mangrove parts - work in classroom related to trip.	Science – plant or community study, parts & functions, drawing scientific diagrams. Year 7 Science Book, Unit 2, pgs. 4 - 6 Art – drawing and colouring. <b>Assessment:</b> Part A: group results copied into students' books. Part B: answers to questions.	Group work, drawing, organising, colouring, observation, identification, naming organisms, knowledge.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
7	To improve vocabulary skills.	<ul style="list-style-type: none"> <li>- define photosynthesis &amp; nurseries</li> <li>- say the Samoan words for particular organisms</li> </ul>	Word Find - find words in maze, definitions & translations.	<p>English – dictionary vocabulary work.</p> <p>Samoan – translations.</p> <p>Science – definitions of processes, identifying organisms.</p> <p><b>Assessment:</b> Finding the correct words, definitions &amp; Samoan names.</p>	Vocabulary, observation & identification
8	To encourage students to voice their opinions about environmental issues by communication with related authorities.	<ul style="list-style-type: none"> <li>- write a letter</li> <li>- state the importance of mangroves</li> <li>- explain the need to protect mangroves</li> <li>- describe ways mangroves are being destroyed</li> <li>- describe ways of protecting mangroves</li> <li>- describe ways of how mangrove community is destroyed</li> <li>- participate in a debate</li> </ul>	<p><u>Part A:</u> - Letter Writing to various people about importance of mangroves &amp; need to protect them.</p> <p><u>Part B:</u> - Debate – development/ economics vs. mangroves</p>	<p>English – letter writing, debate</p> <p>Social science – development versus environment</p> <p>Science – conservation, community study. Year 8 Science Book, Unit 3, pgs 7 – 9.</p> <p><b>Assessment:</b> Part A: group to be assessed on the letter written, that the necessary information is included. Part B: debate to be judged and students to write a paragraph.</p>	Communication, writing, oral and speaking, expressing opinions, making decisions, knowledge, comprehension, application, values & attitudes.



Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
8	To introduce students to field work studying mangrove community.	<ul style="list-style-type: none"> <li>- work in groups to complete set tasks</li> <li>- identify &amp; name organisms</li> <li>- define &amp; describe habitat of an organism</li> <li>- draw &amp; label diagrams of organisms</li> <li>- define community, food chain, producer, herbivore, carnivore</li> <li>- draw a food chain</li> </ul>	<p><u>Part A</u> – Field trip to carry out various activities in mangroves.</p> <p><u>Part B</u> – Classroom work related to activities carried out in the field.</p>	<p>Science – animal or plant study, feeding levels, conservation. Year 8 Science Book, Unit 3, pgs 7 – 9.</p> <p>Art – drawing diagrams.</p> <p><b>Assessment:</b> Marks given for group work and presentation.</p>	Working in groups, leadership, following instructions, drawing diagrams.
8	To introduce students to ways of promoting awareness of environmental issues by drawing & designing posters depicting various aspects of mangroves.	<ul style="list-style-type: none"> <li>- design &amp; draw a poster</li> <li>- describe the importance of mangroves</li> <li>- describe ways of protecting &amp; preserving mangroves</li> <li>- name uses of mangroves in Samoa</li> <li>- name food sources from the mangroves</li> </ul>	Poster making for awareness and promotion of mangroves.	<p>Science/ English/Art conservation, uses, importance of mangroves in Samoa.</p> <p><b>Assessment:</b> Posters produced to be marked.</p>	Design, drawing, socialising, leadership.
9	To promote awareness of students about mangroves in Samoa.	<ul style="list-style-type: none"> <li>- name the 2 main types of mangroves in Samoa</li> <li>- describe differences between the leaves, flowers, seeds, roots of the 2 types of mangroves</li> <li>- draw diagrams of parts</li> </ul>	Field trip – site where the 2 types of mangroves are found to identify & compare them.	<p>Science/ Social Science – mangrove studies. Year 9 Science Book 3, Unit 1, pgs 5 – 14.</p> <p><b>Assessment:</b> Task sheet completed</p>	Working in-group, organising, drawing, comparing.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
9	To gather more information about mangroves from various sources.	<ul style="list-style-type: none"> <li>- listen &amp; ask questions</li> <li>- define renewable resource, sustainable yield</li> <li>- describe main roles of mangroves in coastal environments</li> </ul>	Guest Speaker – Ministry of Natural Resources & Environment to talk about specific topics on mangroves.	English/ Science/ Social Science – conservation, mangrove studies. Year 9 Science Book 3, Unit 1, pgs 5 – 14. <b>Assessment:</b> Report	Listening, note taking, formulating questions, comprehension, communication.
9	To improve vocabulary and knowledge about mangrove conservation.	<ul style="list-style-type: none"> <li>- use words in the correct context</li> <li>- define the various terms</li> </ul>	Word Find – find words & write sentences.	English/ Science/ Social Science – conservation, mangrove studies. <b>Assessment:</b> Words found & correct sentences.	Comprehension , writing, vocabulary.
10	To introduce students to carrying out research work about mangroves and enable them to assess conditions at mangrove stands.	<ul style="list-style-type: none"> <li>- collect information from various sources</li> <li>- select relevant information</li> <li>- work individually or work with others</li> <li>- present information in appropriate way to inform others of a topic</li> <li>- design and carry out an investigation or a research about mangroves</li> <li>- suggest and explain ways of protecting mangroves</li> </ul>	Research – collect information and present to class.	English – topic study. Science/ Social Science – conservation, environment study, sustainable development, utilising good practices for fishing, traditional knowledge. Year 10 Science Book 3, Unit 2, pgs 18 – 31. <b>Assessment:</b> Research.	Research, design, computer, planning, oral, writing, reporting, creativity, communication, group work, critical thinking, field experience, field observations, sharing ideas.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
10	To introduce students to practicalities of mangrove surveys/ assessments.	<ul style="list-style-type: none"> <li>- design &amp; develop questionnaire questions</li> <li>- work in a group</li> <li>- carry out survey by conducting interviews about mangroves</li> </ul>	Field trip to a mangrove area to carry out a survey designed by class.	Science/ Social Science – conservation, case study, methodology, research, survey, assessment, monitoring, data collection. <b>Assessment:</b> Survey analysis.	Interview, social, planning, questioning, knowledge, analysing, undertaking survey, data collection, observation, application.
10	To promote awareness about importance of mangroves and to introduce students to carrying out activities to restore degraded mangrove sites/stands.	<ul style="list-style-type: none"> <li>- state ways to conserve mangroves</li> <li>- design, draw signs, slogans to promote mangrove conservation</li> <li>- organise, work to protect mangroves</li> <li>- write songs or poems to protect mangroves</li> </ul>	<u>Part A-</u> Mangrove Conservation activities.  <u>Part B –</u> Song & poem writing.	English – poems Science – conservation, methodology, assessing conditions at the site, replanting. Art – signs, posters Music – song composition Agriculture – replanting. <b>Assessment:</b> Poem & song competition, conservation awareness items and activities.	Working in groups, organising, leadership, designing, composition, drawing/art, oral, creativity, replanting skills, data collection.

## fact sheet one: Mangroves in Samoa

### MANGROVES

Mangroves are trees that live halfway between land and sea. This is what makes them special; as for most plants salt water is deadly. Mangroves are among the few trees that can grow in seawater and in places where the seawater mixes with the fresh water from the land.

In Samoa, most of the mangroves grow in areas protected by coral reefs. They are found in coastal areas, especially in river estuaries – the wide lower part of a river’s lower end where it meets the sea.

### Samoa’s Mangrove Areas

Mangroves are important because:

- They are good breeding, feeding and nursery grounds for many fish and shellfish;
- They provide a good source of food and income for the community;
- Their parts have some traditional & medicinal uses;
- Their root systems trap and reduce the amount of sediment entering the lagoon and smothering the coral;
- Their root systems anchor the soil and prevent erosion in the coastal zones;
- The areas where they are found have murky, muddy water that protect young fish from predators; and
- They act as wave breakers to protect the coasts from strong wind and high waves

### Mangrove leaves

- Thick waxy leaf to prevent water loss
- Green leaves to absorb light to produce food by photosynthesis
- Dead leaves fall into the water and decay to provide nutrients for the soil and food for other animals.

### Mangrove seeds

- Long, thin and pointed to fall directly to the ground and stick upright in the soft mud
- Some seeds start to germinate or grow while they are still on the tree.
- Seeds can float which helps to spread or disperse mangroves to grow in new areas.
- Can withstand strong wave actions

### Mangrove flowers

- Small and yellow for one type, and bigger and pink for the other type
- Contains the male and female reproductive parts to produce a new mangrove plant.

### Mangrove animals

#### **Fish**

<b>English Name</b>	<b>Samoan Name</b>	<b>Scientific Name</b>
Black spot snapper	Tamala	<i>Lutjanus fulvus</i>
Flag tail	Sesele	<i>Kuhlia</i> sp.
Perch	Avaava	<i>Terapon jarbua</i>
Blue fin trevally	Malauli	<i>Caranx melampygus</i>
Mudskipper	Mano'o	<i>Periophthalmus</i> sp.
Halfbeak	Ise	<i>Hemiramphus</i> sp.
Sleeper	Apofu	<i>Eleotris</i> sp.
Mullet	Aua	<i>Crenimugil</i> sp.
Orbicular batfish	Koko	<i>Platax orbicularis</i>
Snub nose dart	Lalafutu	<i>Pttrachinotus blochii</i>
Fresh-water eel	Tuna	<i>Anguilla</i> sp.
Barracuda	Sapatu	<i>Sphyaena</i> sp.
Indo-Pacific tarpon	A'analagi	<i>Megalops cyprinoides</i>

## Shellfish

<b>English Name</b>	<b>Samoan Name</b>	<b>Scientific</b>
Land crab	Tupa	<i>Cardisoma carnifex</i>
Red claw	U'a	<i>Sesarma sp.</i>
Mangrove crab	Pa'alimago	<i>Scylla serrata</i>
Freshwater prawn	Ula vai	<i>Macrobrachium lar</i>

## Birds

<b>English Name</b>	<b>Samoan Name</b>	<b>Scientific Name</b>
Wattle honey-eater	Iao	<i>Foulehaio carunculata</i>
Banded rail	Ve'a	<i>Gallirallus philippensis</i>
Samoan starling	Fuia	<i>Aplonis atrifusca</i>
Samoan whistler	Vasavasa	<i>Pachycephala flavifrons</i>
Cardinal honey-eater	Segasegamau	<i>Myzomela cardinalis</i>



## Mangrove Plants

<b>English Name</b>	<b>Samoan Name</b>	<b>Scientific Name</b>
Tahitian chestnut	Ifi	<i>Inocarpus fagifer</i>
Beach hibiscus	Fau	<i>Hibiscus tiliaceus</i>
Coconut	Niu	<i>Cocos nucifera</i>
Indian mulberry	Nonu	<i>Morinda citrifolia</i>
Red ginger	Teuila	<i>Alpinia purpurata</i>
Bird nest fern	Laugapapa	<i>Asplenium nidus</i>
Epiphytic orchids	Oketi	<i>Dendrobium sp.</i>
Chinese orange	Moli saina	<i>Citrus reticulata</i>

## Mangrove Uses

- Building materials – houses, fences, furniture and carving
- Food and income – fish, crabs, shrimps, eels harvested for food and for selling all live in the mangroves
- Firewood – wood used for fuel
- Handicraft – dyes for siapo or tapa, flowers to make garlands
- Samoan medicine – roots, barks and leaves

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• **Going into the Mangroves.** 2005. MNRE, SPREP, UNESCO, UNEP  
SPREP. **Mangroves in the South Pacific. Fact sheet 6.**  
Samoa CSI Project, Getting to know the Mangroves.

## YEAR 7

### Activity One: Where are the Mangroves?

**AIM:** To identify & name mangrove areas of Samoa.

#### Materials

- enlarged map of Samoa, newsprint, markers

#### Time

- one class period

#### What to do

- Teacher to use map in fact sheet one for this activity
1. Divide the class into groups of fives and give each group newsprint and markers.
  2. Each group to trace a map of Samoa.
  3. Ask students to locate their village and school on map and label.
  4. Ask students to mark and label areas where they know or think mangroves are located. Explain why they are found only in certain villages and not in others.
  5. Students to identify and respond.
  6. Groups will then show their work and class discussion should follow. Discuss groups' work.
  7. Teacher will then pin up wall map of Samoa where mangroves are found and discuss with class.
  8. Students to make corrections in their map work.

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• Map from: **Going into the Mangroves**. 2005. MNRE, SPREP, UNESCO, UNEP

## Activity Two: The Mangroves

**AIM:** To identify structure & functions of mangrove plants, & study the mangrove community.

**Note:** This activity is in two parts. If your school is situated near to a mangrove area, then carry out Part A. If there are no mangroves near your school, you may carry out Part B. You may choose to do both.

**Part A:** - Mangrove Walk

- Teacher to organize a field trip to the mangroves.

### Materials

- pen & paper (clipboard if available), newsprint, markers

### Time

- 2 class periods

### What to do

1. Divide class into groups of four or five.
  2. Each group to look at a mangrove plant, and name all organisms found on or near the mangrove. Make a list of organisms.
  3. Collect a leaf, flower and seed for each group.
  4. Observe the seed and note how it is shaped and discuss the function of the seed.
  5. Observe leaves and discuss function and structure.
  6. Observe flowers and discuss function.
  7. Observe roots and discuss function.
  8. Note any other interesting facts about the mangroves.
  9. Each group to draw a leaf, seed and flower.
  10. Write down two uses of mangroves.
- Each group will be given newsprint or brown paper for their results to be displayed
  - Results should include: - list of organisms found on or near the mangroves
    - two uses of mangroves
    - diagrams of a leaf, seed and flower with labels and functions
    - any other interesting facts
  - Students to copy their group results into their books.

Part B: - Colouring mangrove parts

**Materials**

- diagrams
- coloured pens/crayons

**Time**

- one class period

**What to do**

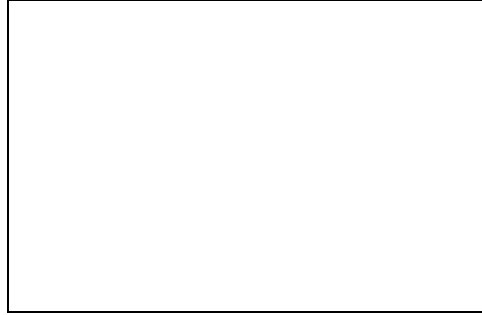
- From the following diagrams, answer the questions in their books. Give a title for each diagram.
1. Label the leaves and roots of the mangroves below.
  2. Colour the diagram.
  3. Name the other organisms in the diagram.



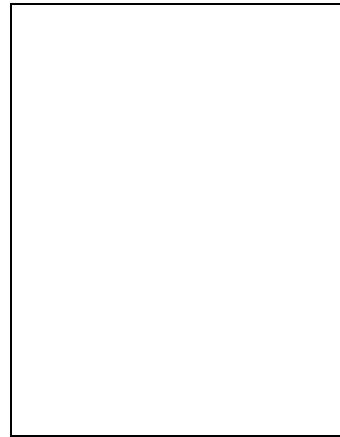
4. What is the function of the roots shown?
5. Why are the mangrove roots shaped like this?



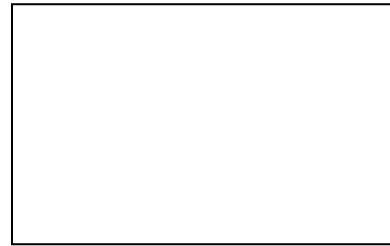
6. Colour the leaves shown.
7. What is the function of the leaves?



8. What is the function of the seed?
9. Why is the mangrove seed shaped like this?



10. What is the function of the flower?
11. Colour your flower yellow.



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• Diagrams from: **Going into the Mangroves**. 2005. MNRE, SPREP, UNESCO, UNEP

## Activity Three: Word Find

**AIM:** To find, translate & define words.

**Materials**

- copies of word maze

**Time**

- one class period

**What to do**

1. Find the following words in the grid below by circling the letters. They may be up, down, backwards or diagonal.
2. Define: photosynthesis and nurseries.
3. Find out the Samoan words for mudskipper, land crab and wild duck.

**Word List:**

photosynthesis	mudskipper	land crab
wild duck	coconut	mangrove
roots	nurseries	firewood
seeds		

W	T	I	L	S	E	I	R	E	S	R	U	N	M
I	I	A	A	O	W	N	A	S	T	O	N	U	A
L	M	L	N	F	I	R	E	W	O	O	D	R	N
L	A	N	D	C	R	A	B	E	R	S	E	S	G
D	N	P	R	D	E	T	O	L	K	T	R	E	R
U	G	O	O	U	U	E	Y	I	S	Y	N	S	O
C	O	O	V	C	P	C	P	T	A	C	E	H	V
K	E	R	E	K	B	P	K	S	N	O	A	O	E
W	S	S	R	S	E	O	I	R	D	C	T	M	P
K	E	D	S	R	A	L	D	O	D	O	H	E	L
E	E	E	E	O	R	I	D	O	O	N	T	A	A
E	T	E	A	T	D	T	Y	T	V	U	O	N	N
S	I	S	E	H	T	N	Y	S	O	T	O	H	P



## fact sheet two: Roles, Threats & Protection of Mangroves

Mangroves play an important role in many coastal environments.

### **Mangroves provide an important source of food for fish and other marine creatures.**

Mangroves take up nutrients through their root systems. The leaves fall and decay or rot to form a constant supply of food for crabs, prawns and some fish.

### **Mangroves are a valuable and renewable resource for coastal people.**

Mangroves provide dyes or colouring material, and wood for cooking and building. They can continue to be used this way forever, as long as the number of mangroves cut down is no more than that which can be replaced by natural growth. This quantity is called the **sustainable yield**.

### **Mangroves provide a home for many marine species, which are used by people as food and a source of income.**

Mangroves provide .....

- a) *Permanent homes* for some species such as oysters and mud crabs.
- b) *Nursery areas* for animals such as prawns. Some fish such as the mangrove mullet stay in mangrove nursery areas for 3 to 4 years before moving to sea to spawn.
- c) *Feeding areas* for larger fish, which visit the mangroves areas to feed on smaller fish and other creatures.

### **Mangroves protect and build up shorelines.**

Mangroves form an underground network of roots, which hold the earth together and prevent it being washed away. Above the ground, the roots act like a comb and trap particles and sediment; in this way mangroves build up and extend shorelines.

### **Mangroves provide shelter for many plants, animals and birds.**

The mudskipper (mano'o) is a small fish the can climb up the roots of mangroves.

### Mangrove threats

Many people consider the mangroves to be dirty, useless and mosquito-ridden places, without understanding that the destruction of these areas will affect our way of life.

### **Poor land management.**

When land is cleared for construction or agricultural purposes, the soil is easily washed away during heavy rains. This dirt and sediment is carried downstream to the mangrove forest where it can cover the roots and kill the trees and affect the animals that live in the water.

### **Cutting the mangrove forest.**

Cutting some trees will not destroy the mangrove forest if it is done in a **sustainable** way. It is important to remember that mangroves are not fast growing trees.

### **Construction and reclamation of land.**

Large areas of mangroves are being cleared and filled for businesses, buildings and roads. Some constructions alter or stop the amount of fresh and seawater entering the mangroves. This will affect the growth of the trees.

### **Water pollution and rubbish.**

Oil and gasoline from faulty outboard motors and spills create a thin film that sticks to the mangrove roots. Household rubbish like plastic bags contaminate the mangrove areas affecting the organisms there. In some areas, sewage is disposed in the mangroves, which results in excessive algal growth that kills the other marine life.

### **Taking care of mangroves**

#### **Education**

Teaching our people about the importance of mangroves will result in wise decisions and sustainable use of these amazing trees.

#### **Monitoring**

Keeping an eye on the mangrove forest and animals that use them. Check the way people are using it.

#### **Awareness**

Community awareness activities and be done in schools and villages so that people will use and respect the mangroves.

#### **Reforestation**

Replanting mangroves will benefit us all.

#### **Mangrove reserves**

Creating more will benefit the coastal villages through ensuring food and protection for future generations. It will also protect the culture and heritage of Samoa.

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• **Going into the Mangroves.** 2005. MNRE, SPREP, UNESCO, UNEP  
SPREP. **Mangroves in the South Pacific. Fact sheet 6.**

## YEAR 8

### Activity One: Letter Writing & Debate

**AIM:** To write letters & arguments relating to the importance of mangroves.

**Note:** This activity is in two parts. If your school is situated near a mangrove area, then carry out Part A. If there are no mangroves near your school, you may carry out Part B. You may choose to do both.

Part A: - Letter Writing

#### Materials

- pen & paper

#### Time

- two class periods

#### What to do

1. Divide class into 4 groups.
2. Each group will write a letter to one of the following using brown paper or newsprint;
  - (i) Village council of chiefs
  - (ii) Member of parliament of the district
  - (iii) Ministry of Natural Resources and Environment
  - (iv) SPREP

The letter should include the following information:

- a. the importance of mangroves
  - b. the need to make rules to protect the mangroves
  - c. describe ways that the mangroves are being destroyed by people
  - d. suggest methods that may be carried out to protect and preserve mangroves
3. Each group will then read their letter to the class. The rest of the class will act as the recipients of the letter; the village council, the member of parliament, CEO of the MNRE and the director of SPREP.
  4. After each letter, the class will then discuss and give a reply to the letter.
  5. Discussion should follow after each letter about the issues raised.

Part B: - Debate

**Materials**

- pen & paper

**Time**

- two class periods

**What to do**

1. Divide class into two groups for a debate.
2. One group will be for and the other against the following topic;

**“Mangrove community should be reclaimed and used to build a hotel”**

3. Groups will discuss and select 3 speakers to represent them.
4. Carry out debate. You may invite other teachers or parents to be the judges.

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\* Diagram from: **Going into the Mangroves**. 2005. MNRE, SPREP, UNESCO, UNEP

## Activity Two: Who eats what?

**AIM:** To carry out field work studying the mangrove community.

**Note:** This activity is in two parts. If your school is situated near to mangroves, then carry out Part A. If there are no mangroves near your school, you may carry out Part B. You may choose to do both.

Part A: - Mangrove community

- Teacher to organize a field trip to a nearby mangrove community.

### Materials

- pen & paper
- newsprint/brown paper

### Time

- 2 class periods

### What to do

1. Divide class into groups of four or five.
2. Each group will select an area of the mangrove community to work in.
3. List all animals and plants found in your study area. You may use Samoan names for your organisms.
4. Choose one animal and one plant from your list. You will complete the following about your chosen animal and plant:
  - (i) Name your plant and animal.
  - (ii) Draw a diagram of your plant and animal and label it.
  - (iii) Describe the habitat of your plant and animal.
  - (iv) Describe the importance of your plant and animal in the mangrove community.
    - i. Draw a food chain with 4 links from your list of organisms found in the mangrove community.
    - ii. List the organisms that your family eats that you found in the mangrove community.
    - iii. Each group to display all results on brown paper or newsprint for presentation in the classroom.

Part B: - Mangrove Community

**Materials**

- list of animals and plants found in mangrove community in Fact Sheet One
- diagrams of some of these organisms

**Time**

- two class periods

**What to do**

1. Students to identify and draw and label diagrams of two animals and two plants from the lists.
2. List animals and plants your family uses and eat that are found in the lists and discuss.
3. Write two food chains with 4 links from the lists of organisms in the mangroves.
4. Choose one animal and one plant from the list. You will complete the following about your chosen animal and plant:
  - (i) Name your plant and animal.
  - (ii) Draw a diagram of your plant and animal and label it.
  - (iii) Describe the habitat of your plant and animal.
  - (iv) Describe the importance of your plant and animal in the mangrove community.

## Activity Three: Poster Making

**AIM:** To design & draw posters to promote awareness about the importance of mangroves.

- The activity may be carried out as a competition and all posters will be displayed.

### Materials

- newsprint/brown paper/cardboard
- markers/colouring pens/crayons

### Time

- two class periods

### What to do

1. Class to work in their groups as for the other activities.
2. Groups will be given newsprint or cardboard to draw posters.
3. Each group to design and draw a poster or a wall chart on mangroves. The group will decide on the theme for their poster. The following are suggestions:
  - a. importance of mangroves
  - b. protect and preserve mangroves
  - c. animals and plants in the mangroves
  - d. food from the mangroves
  - e. uses of mangroves

Red mangrove *Rhizophora* in Samoa:

Retrieved from <http://www.botgard.ucla.edu/html/botanytextbooks/worldvegeta...>



## fact sheet three: Types of Mangroves

### Two common types of mangroves found in Samoa

Red mangrove (*Rhizophora*), is supported on stilt roots which grow like arches from high up in the tree. The stilt roots enable it to survive changes in the levels of the mud and sand.

*Bruguiera* type mangroves have buttress roots – thick vertical slabs – growing around the base of the trunk.

<b>Features</b>	<b><i>Rhizophora</i></b>	<b><i>Bruguiera</i></b>
<b>Tree trunk size &amp; height</b>	Not as big as <i>Bruguiera</i>	Tall and big
<b>Shape of the whole tree</b>	Oval	Not oval
<b>Leaves</b>	Tips of the leaves are blunt	Tips of leaves pointed
<b>Flowers</b>	Whitish yellow	Pink
<b>Seeds</b>	Longer & thinner	Short & fat
<b>Stems</b>	Thin & short	Tall, thick & strong
<b>Roots</b>	Prop or stilt roots. Mostly above the ground (Arched roots growing from the stem)	Knee roots. Mostly underground. (Knee like roots in the mud)
<b>Where it is found</b>	Towards the water/sea	In the mud or towards the land

*Rhizophora* stilt or prop roots.

*Bruguiera* knee roots.

*Rhizophora* leaves.



*Bruguiera* leaves.

*Rhizophora* seed.

*Bruguiera* seed.

*Rhizophora* flower.

*Bruguiera* flower.

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• **Going into the Mangroves.** 2005. MNRE, SPREP, UNESCO, UNEP

## YEAR 9

### Activity One: Types of Mangroves in Samoa

**AIM:** To study the types of mangroves found in Samoa.

- Field trip to an area where the two types of mangroves are found.

**Materials**

- clipboard/pen/paper

**Time**

- two class periods

**What to do**

- Class may be divided into groups or work in pairs to complete the work.
- Work sheet may be copied by students if photocopier not available at school.

1. Look for the two types of mangroves and complete the following work sheet.

Name of Mangrove area	
Name of mangrove type 1	
Where it is situated in the mangrove area	
Description of leaf and draw a diagram	
Function of leaf	
Description of roots and draw a diagram	
Function of roots	
Description of flower and draw a diagram	
Function of flower	

Description of seed and draw a diagram	
Function of seed	
Size and height compared to other type	
Name of mangrove type 2	
Where it is situated in the mangrove area	
Description of leaf and draw a diagram	
Description of roots and draw a diagram	
Description of flower and draw a diagram	
Description of seed and draw a diagram	
Size and height compared to other type	

## Activity Two: Guest Speaker

**AIM:** To define renewable resources, sustainable yield & find out information about what the Government's role is in the protection of mangroves.

- Invite a specialist on mangroves from the Ministry of Natural Resources and Environment to talk about mangroves to the class.

### Materials

- guest speaker

### Time

- one class period

### What to do

1. Students should have questions ready to ask the specialist about the mangroves. These should include the following;
  - (i) main roles of mangroves in coastal environments
  - (ii) renewable resources
  - (iii) sustainable yield
  - (iv) protected mangrove areas
  - (v) other types of mangroves in Samoa
  - (vi) role of the Ministry in mangrove protection
  - (vii) role of students and schools
2. Students are expected to write a full report on the talk given by the guest speaker.

## Activity Three: Word Find

**AIM:** To find words in the maze & use them to write sentences about mangroves.

**Materials**

- copies of word maze

**Time**

- one class period

**What to do**

1. Find the following words in the grid below by circling the letters. They may be up, down, backwards or diagonal.
2. Write a sentence related to the mangroves using each of the words in the word list.

**Word List:**

renewable	sustainable	prop roots
knee roots	disperse	flower
income	herbivore	wildlife
rubbish	sewage	reserve

R	U	N	N	R	O	O	P	T	S	B	R	R	H
U	E	U	D	I	S	P	E	R	S	E	O	E	U
B	M	N	R	C	O	M	E	H	O	M	R	A	N
B	O	O	E	E	O	V	R	A	I	B	E	A	N
I	C	F	S	W	O	M	E	N	I	N	K	I	T
S	N	T	E	I	A	T	W	V	A	I	N	O	E
H	I	H	R	L	O	B	O	F	T	H	E	R	A
E	N	E	V	D	O	R	L	O	V	E	E	T	C
R	C	A	E	L	E	N	F	E	M	U	R	I	D
N	U	B	A	I	S	T	O	O	R	P	O	R	P
I	T	V	L	F	O	R	Y	O	U	R	O	N	L
E	G	A	W	E	S	U	S	T	A	I	T	L	O
E	L	B	A	N	I	A	T	S	U	S	S	O	B

## fact sheet four: Future of Mangroves

In Samoa as in many Pacific islands, mangrove areas are still used and regarded as rubbish dumps. The trees are cut down and the land is filled in for housing and other development. Some coastal road construction, which interrupts the mixing of fresh and salt water, also creates an environment unsuitable for mangroves. In some cases, there has been an attempt to conserve the mangroves by good planning and environmental engineering using large pipes under new roads to allow the passage of tidal seawater and freshwater needed by mangroves.

Eco-tourism is practiced in Samoa, where tourists and visitors pay for canoe tours through some mangrove areas. More mangrove areas are now protected by villages and the government. There have also been attempts by some groups to re-establish areas that have been cleared. This involves the hand planting of mangrove seeds or propagules in suitable areas. These are some of the projects carried out by some groups and villages on Environment Day in Samoa. An example of a well-managed mangrove site is the Sa'anapu-Sataoa Conservation Area. Mangroves are also conserved and protected at Moata'a.

Awareness programmes carried out by the Ministry of Natural Resources and Environment have informed Samoans about these amazing trees. The curriculum designed by the Ministry of Education, Sports and Culture includes environmental awareness for all students.

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\* King, M. **From mangroves to coral reefs**. 2004 SPREP

## YEAR 10

### Activity One: Research

**AIM:** To collect & present relevant information about mangroves.

- Students may work individually or in pairs for this activity to collect information about mangroves and present to class.

#### **Materials**

- various information sources on mangroves made available for students to use
- list of places students may use to collect relevant information
- letters to various offices that student may visit to gather information
- example or sample of research done

#### **Time**

- 4 class periods and students' own time  
(**NOTE:** Teacher may use some class time to explain activity and give a sample research paper for students to have an idea about acceptable & standard format of research writing, start data collection in classroom using resources provided by teacher, and some time for students to prepare the presentation of data.)

#### **What to do**

1. Teacher to explain to students what the activity is. Instructions must be clear.
2. Students will collect information and present either as a poster, pamphlet, book research or a power point presentation.
3. Information collected and presented must include the following;
  - (i) Why are mangroves important?
  - (ii) What is happening to the mangroves?
  - (iii) What are the effects of man's activities on the mangroves?
  - (iv) What possible solutions will solve the problem?
  - (v) Why is it important to use the mangroves in a responsible way?
4. Display student work and have a class discussion.

## Activity Two: Survey

**AIM:** To design & carry out a survey about peoples' opinions & effects on the mangrove community.

- Field trip to a nearby mangrove community after preparation in the classroom. This survey is to find out what people think of mangroves, how they have used these plants, the effects of their actions on the mangroves and if they are protecting and conserving the mangroves.

### **Materials**

- survey questionnaire

### **Time**

- 3 class periods; prepare questionnaire, carry out survey, analyse and discuss survey results

### **What to do**

1. A questionnaire will be developed by the class consisting of what they need to find out. Brainstorming ideas with teacher to lead and guide students.
2. Divide the class into groups of fives. Each group will be responsible for a particular part of the village to conduct five home visits to complete the questionnaire.
3. Each group will then summarise their findings and report back to the class.
4. During the reporting, all groups will write their responses on a chart for the class to discuss.



## Activity Three: How can we help?

**AIM:** To design & develop awareness to promote protection of the mangroves.

**Note:** This activity is in two parts. If your school is situated near to mangroves, then carry out Part A. If there are no mangroves near your school, you may carry out Part B. You may choose to do both.

### Part A:

#### **Materials**

- art materials to write signs
- newsprint/brown paper
- guest speaker

#### **Time**

- 2 class periods and own time

#### **What to do**

1. Class to discuss how they can help to protect and conserve mangroves. What can they do? Write all ideas on a wall chart.
2. Students to write signs to stop littering or dumping rubbish at the mangroves/protect and conserve mangroves or other ideas suggested by them. Set up these signs at the mangrove sites.
3. Arrange a clean up to pick up rubbish at the mangrove area selected or near to school. Students to discuss and teacher to make necessary arrangements with Head Teacher, parents and village council.
4. Teacher may also invite a specialist from the Ministry of Natural Resources and Environment to talk about replanting and demonstrate to students. This may be another activity to go hand in hand with rubbish pick up.

### Part B:

#### **Materials**

- songs or poems
- musical instruments
- newsprint/brown paper

#### **Time**

- 2 class periods; composition, presentation

#### **What to do**

1. Divide class into groups to compose a song or poem about mangroves. It should mention their importance, how we can protect them and why they should be conserved.
2. This will be a competition and each group will perform their song or poem.
3. Carry out the competition during a school assembly and invite parents.

## V. TOPICS GUIDE CHART

### WASTE MANAGEMENT

Yr	Objectives	Learning outcomes	Activity description	Curriculum connection	Skills
7	To introduce students to the classification of waste & designing a rubbish collection & disposal programme at school.	<ul style="list-style-type: none"> <li>- sort the different rubbish around the school</li> <li>- explain why they have sorted the rubbish in these groups</li> <li>- explain how they can dispose of the rubbish in an environmentally safe way</li> </ul>	Sorting rubbish and starting rubbish collection and disposal programme for the school.	Science/ English/ Social Science/ Health – pollution, waste/ litter/ rubbish. Year 7 Science Book, Unit 3 & 5, pgs 7 –9, 12 – 14. <b>Assessment:</b> Class project, work written in books.	Social, knowledge, sorting, reasoning, physical, creativity, organising.
7	To introduce students to recycling wastes in Samoa & to promote awareness to reduce & recycle waste.	<ul style="list-style-type: none"> <li>- define recycle</li> <li>- name waste that can be recycled</li> <li>- state advantages of recycling</li> <li>- design &amp; make posters to promote awareness about littering &amp; recycling.</li> </ul>	Poster making & recycling exercise.	Science/ Health – Hygiene, Waste disposal English – Recycling. <b>Assessment:</b> Group posters..	Creativity, working in groups, organising, leadership, communication, oral & speech, drawing.
7	To promote awareness of students about their contribution to waste accumulation & ways of reducing waste.	<ul style="list-style-type: none"> <li>- use a beam balance</li> <li>- estimate masses</li> <li>- collect and sort rubbish</li> <li>- draw a histogram &amp; frequency table</li> <li>- state ways of reducing rubbish at home</li> <li>- calculate masses</li> <li>- identify &amp; state problems.</li> </ul>	Identifying rubbish at home and looking at ways of reducing waste.	Science – waste management Maths – histograms. <b>Assessment:</b> Histograms and answers to questions.	Weighing, estimating, knowledge, application, graphing, calculations.
Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills

8	To introduce students to field study, observations & collection of data to base conclusions on.	<ul style="list-style-type: none"> <li>- define pollution, pollutant</li> <li>- observe &amp; identify pollutants</li> <li>- carry out survey in groups</li> <li>- discuss effects of water pollution on health and hygiene</li> </ul>	Field trip to survey water pollution or make own water sources in classroom for use.	Science/English/ Health – water pollution. Year 8 Science Book, Unit 3 & 5, pgs 7 – 9 & 13 - 15. <b>Assessment:</b> Write up of activity after completing worksheet.	Observation, communication, social, vocabulary,
8	To carry out recycling.	<ul style="list-style-type: none"> <li>- follow instructions</li> <li>- make recycled paper</li> <li>- use recycled paper</li> <li>- state importance of recycling</li> <li>- name other waste that can be recycled</li> </ul>	Making recycled paper.	Art – waste reduction English – following instructions Science – recycling of waste, saving forests. <b>Assessment:</b> Quality of paper produced & used.	Vocabulary, comprehension, social, knowledge.
8	To learn from experts about waste management in Samoa.	<ul style="list-style-type: none"> <li>- define waste management</li> <li>- listen to speaker &amp; take notes &amp; ask relevant questions</li> <li>- describe environmental and health problems associated with waste</li> <li>- name ways of reducing waste in Samoa</li> </ul>	Guest speaker to talk about Waste Management in Samoa.	English / Science / Social Science – waste management. <b>Assessment:</b> Report about the talk & production of class wall chart.	Listening, oral, communication, asking questions, knowledge.
Yr	<b>Objectives</b>	<b>Learning Outcomes</b>	<b>Activity Description</b>	<b>Curriculum Connections</b>	<b>Skills</b>

9	To carry out composting.	<ul style="list-style-type: none"> <li>- see compost heap demonstrated</li> <li>- listen to specialist talk &amp; make notes &amp; ask relevant questions</li> <li>- make compost</li> <li>- follow instructions</li> <li>- work in groups</li> <li>- define compost</li> <li>- state advantages of compost &amp; its uses</li> </ul>	Guest Speaker to talk about compost and demonstrate making a compost heap, then students themselves will make another compost heap.	Science/ Agriculture - reducing waste, composting, microorganisms. Year 9 Science Book 1, Unit 6. pgs 65 – 76. <b>Assessment:</b> Carrying out composting & maintaining heap.	Listening, communication, following instructions, group work, physical, co-operation.
9	To grow plants & maintain a garden.	<ul style="list-style-type: none"> <li>- plan &amp; design garden</li> <li>- use compost for garden soil</li> <li>- plant crops or flowering plants</li> <li>- work co-operatively as a class</li> <li>- describe advantages &amp; disadvantages of pesticides &amp; fertilizers</li> </ul>	Planning and growing a garden making use of compost soil.	Agriculture / Science – growing plants. Year 9 Science Book 1, Unit 1, pgs 5 – 14. Year 9 Agricultural Science Book 3, Units 7 & 8, pgs 53 - 101. <b>Assessment:</b> Participation in garden work, selling produce.	Planning, physical, communication, co-operation, knowledge, fitness.
9	To promote wise waste disposal in the school & at home.	<ul style="list-style-type: none"> <li>- design a waste disposal strategy</li> <li>- work in pairs</li> <li>- compare, evaluate and improve ideas</li> <li>- carry out strategy at home and school</li> <li>- apply strategy to other circumstances</li> </ul>	Waste disposal strategy – design, plan and carry out at home and apply to other circumstances .	English – design activity Science – project on waste disposal. <b>Assessment:</b> Strategies for waste disposal.	Creativity, planning, designing, physical, evaluating, comparing, application, work in pairs.
Yr	<b>Objectives</b>	<b>Learning Outcomes</b>	<b>Activity Description</b>	<b>Curriculum Connections</b>	<b>Skills</b>

10	To visit and carry out observations at a field site for waste disposal in Samoa.	<ul style="list-style-type: none"> <li>- describe the Fukuoka Method</li> <li>- see the Fukuoka method</li> <li>- draw a sketch of the site</li> <li>- ask relevant questions</li> <li>- answer questions</li> <li>- observe rubbish &amp; effects on environment</li> <li>- make conclusions about waste</li> <li>- see what happens to their rubbish</li> <li>- appreciate work done by the people concerned about waste</li> </ul>	Field trip to Tafaigata rubbish dump to look at Fukuoka Method and types of waste disposed there and how they are processed.	<p>Science – waste disposal, diseases, water quality.</p> <p>Health – diseases, sewage disposal.</p> <p>Social Science – land use, waste disposal.</p> <p><b>Assessment:</b> Completion of worksheet &amp; production of wall chart in the classroom.</p>	Observation, reporting, listening, oral, knowledge, values & attitudes.
10	To introduce students to carry out a research by using various sources to collect information and processing this data to present to the class.	<ul style="list-style-type: none"> <li>- describe safe disposal methods for sewage &amp; hospital waste</li> <li>- describe effects of these wastes on environment &amp; health</li> <li>- work in groups</li> <li>- carry out research &amp; collect, arrange, select &amp; present facts</li> </ul>	Research about sewage and hospital waste; their safe disposal and effects. Specialists on the topics invited to talk & provide information for students.	<p>Health / Science– waste &amp; diseases.</p> <p>Year 10 Science Book 1, Unit 5, pgs 54 – 66.</p> <p><b>Assessment:</b> Oral presentation of results.</p>	Oral, listening, research, computer, creative, social, knowledge, values & attitudes, writing & communication.
10	To promote awareness in students to reuse and to recycle waste.	<ul style="list-style-type: none"> <li>- design &amp; create items from waste</li> <li>- work in groups</li> </ul>	Designing and creating useful items from waste.	<p>English / Social Science / Science – project for reusing waste.</p> <p>Home economics / Industrial arts / Art – using scrap materials.</p> <p><b>Assessment:</b> Judging the quality of the items produced from waste.</p>	Design, creativity, physical, social, organising, leadership, communication, knowledge.

# fact sheet five: Types of Waste

## WASTE MANAGEMENT

Waste is any liquid, gaseous or solid item or material that is discarded or rejected for further use. We all create waste every day.

### Types of waste

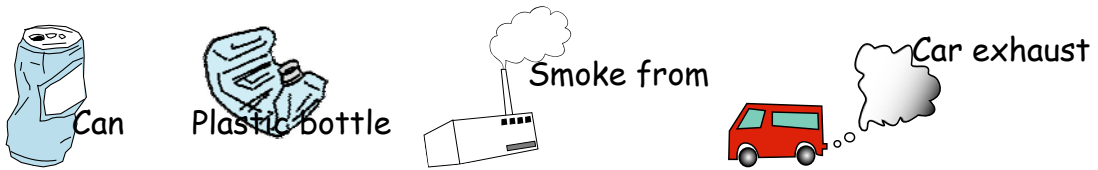
Waste is divided into two groups:

#### (i) **Biodegradable waste**

Living waste is based on natural material, so they can be decomposed into soil by the bacteria. Leaves, trees, dead animals and food waste are examples.

#### (ii) **Non-biodegradable waste**

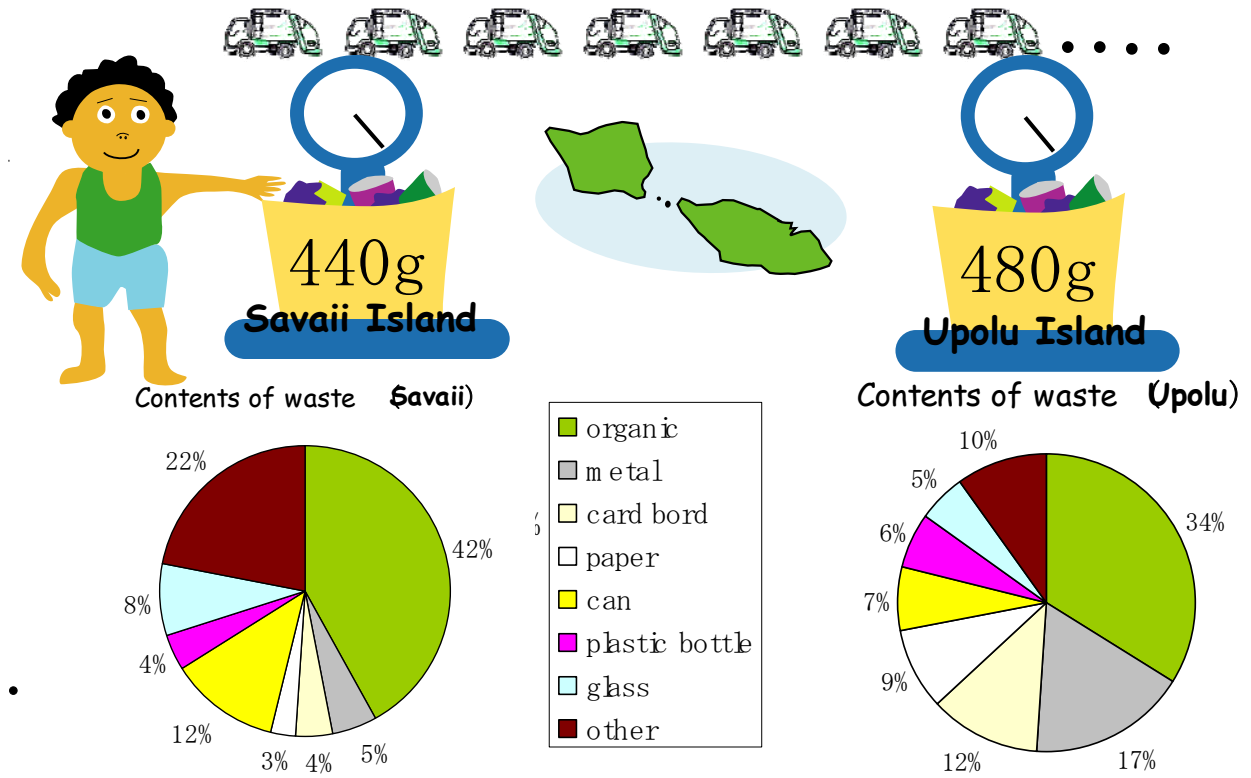
Non-living waste and takes thousands of years to be decomposed. Cans, plastic, cars and glass are examples.



### Generation of Waste

One person generates **440g** of waste every day in Savaii, and **480g** in Upolu.

It means we generate about **60 trucks of waste in Samoa every day!**



\* Lisa Muranaka: MNRE, Waste Management Files.

## YEAR 7

### Activity One: What rubbish is this?

**AIM:** To sort, classify school waste & design a rubbish collection programme.

#### Materials

- rubbish bags/ sacks/baskets/bins/gloves

#### Time

- one class period

#### What to do

1. Class to pick up rubbish in the school compound after lunch and take outside the classroom.
2. Ask the students to sort the rubbish into groups. Discuss how they sort and why they have sorted the rubbish this way.
3. Do they sort their rubbish at home? Discuss and talk about the rubbish at home.
4. Ask and discuss how the different groups of rubbish will be disposed of and why.
5. Give students cardboards to write down the different groups of rubbish collected. These can be placed at a particular area of the school and boxes or rubbish bins can be placed there as well.
6. This can be a class project – being responsible for sorting and disposing of the rubbish in school, responsible for providing the bins to collect the rubbish.
7. Students to write down the main groups of rubbish found and how they can be disposed safely in their notebooks.

#### Students sorting rubbish they collected.



**Rubbish collected by students.**



**Rubbish after sorting into plastic, aluminium cans and plastic bottles.**



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• Photos from Lisa Muranaka: MNRE Power point presentation – Bio & Non-degradable Waste



## Activity Two: Poster Making

**AIM:** To define & carry out a recycling plan for school & domestic waste.

- Teacher should enquire at the MNRE and other related companies for assistance in acquiring bins for use.

### Materials

- containers and place to store collections, newsprint and markers

### Time

- one class period to organise, discuss and explain activity and can collect for one term or the whole year

### What to do

1. Write the word RECYCLE on the board. Discuss with class what it means and how it is related to waste.
2. Identify and name waste common in school and homes that can be recycled: glass bottles, aluminium cans, plastic bottles, paper. Discuss advantages of recycling.
3. Organise the class into four groups. Assign one of the following themes for two groups to make a poster.  
  
“No Littering at School”  
“Recycle & Reuse”
4. Students to present their group posters to the class and make extra copies.
5. Display some in the classroom & some around the school compound.

### Recycling of aluminium cans for export, importers responsible for recycling



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\* Sagapolutele, F. Photo from power point presentation **Samoa Waste** 2006 MNRE

## Activity Three: Rubbish at Home

**AIM:** To promote awareness of students about their contribution to waste accumulation & ways of reducing waste.

**Materials**

- beam balances
- wall chart for frequency table and histogram

**Time**

- two class periods for explaining activity, collecting the data and analysing

**What to do**

1. Ask each student to make a record of what her/his family throws away in one day in their notebooks. They should sort the waste into the groups they did in Activity One and add any new ones.
2. Demonstrate how to use a balance for weighing and students can practice.
3. Students should give the mass (in grams) for each type. If no balances are available these can be estimated or counted. They will need the help of family for this information.
4. Using the information for one day, calculate the mass of each type for one week.
5. Draw a frequency table for the class data on a wall chart.
6. Plot a histogram of the class data.
7. Discuss the results displayed by the histogram and answer the following questions:
  - (a) Do you generate a lot of waste at home?
  - (b) Where does the waste go?
  - (c) What problems are associated with its collection and storage?
  - (d) How can you reduce the rubbish at home?
  - (e) How will all this rubbish affect your health and how it is disposed?

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• Government of Samoa: MESC, Year 10 Science Book 1.

## fact sheet six: Pollution

### Pollution

Pollution is the deterioration in the quality of our environment as a result of human activities. It is simply the way in which we spoil our environment. It is an increasing problem for many island nations as populations grow and more sophisticated lifestyles are adopted.

Pollution can affect our land, our air and our water. It does not only affect the environment of any one organism but also the ecosystem of which it is a part. Wastes that we discard contribute to pollution especially those that include toxic and hazardous substances.

### Land pollution

Land pollution is likely to pollute the environment longer than the case of water and air pollution due to the less movement of toxic substances.

Dumping waste is one of the main ways of polluting land. Therefore, in Samoa, at the Tafaigata landfill, the collected waste is dumped in landfill and its leachate (liquid from waste) is monitored to prevent the land from erosion. However, illegal dumping is a serious problem. The waste without any treatment pollutes the soil directly and the toxic substances penetrate into ground water

### Water pollution

This is the result from industrial effluents and household effluents. Household effluent is from kitchens, bathrooms and washings.

Also illegal dumping is another source. Cars, tires, bicycles, refrigerators, drums, plastic and other household waste are illegally dumped into rivers and sea. These illegal dumpings pollute rivers, ruin the scenery, fishes and other organisms that cannot live in the polluted water. Residents and the government should work together to stop illegal dumping, and clean up the rivers. Illegal dumping is fined, 500 WST to households and 5000 WST to companies. (Government of Samoa, 2008')

### Effect on the ecosystem

There was no "waste" before human beings were created. Leftover from animals, carcasses, fallen leaves, dead trees and sewage were decomposed into the soil and enriched the soil. The enriched soil was perfect for plant growth. Thus all of them were recycled in the ecosystem. However, the current waste (mainly from petroleum) created by humans cannot be recycled in the ecosystem because it takes thousands of years to be decomposed into the soil.

The leftover waste covers the surface of the ground which causes the plants to die resulting from not enough sunlight for photosynthesis. No plants means there will also be no animals.

The following shows the number of years that is needed for some familiar products to be decomposed into the soil; Iron-100 years, Aluminum cans- 500 years and Glass bottles- 1million years.

### Plastic waste-semi permanent

Turtles mistake floating transparent plastic bags for jellyfish and eat them. In one dead turtle found off Hawaii in the Pacific, more than 1000 pieces of plastic were found in the stomach. A recent US report concluded that more than 100,000 marine mammals die each year in the world's oceans by eating or becoming entangled in plastic rubbish, and the position is worsening World-wide, 75 marine bird species are known to eat plastic articles.

### **Plastic bag caught in mouth of turtle**



### Air Pollution

Burning waste is still common in Samoa. Burning is easier than taking the waste to the rubbish stand. However, many countries in the world already have prohibited the burning of waste at home and school due to the high possibility of damage to public health.

Dioxin is the main cause. Dioxin is one of the most toxic chemicals known to science.

Dioxin is formed by burning chlorine-based chemical compounds with hydrocarbons.

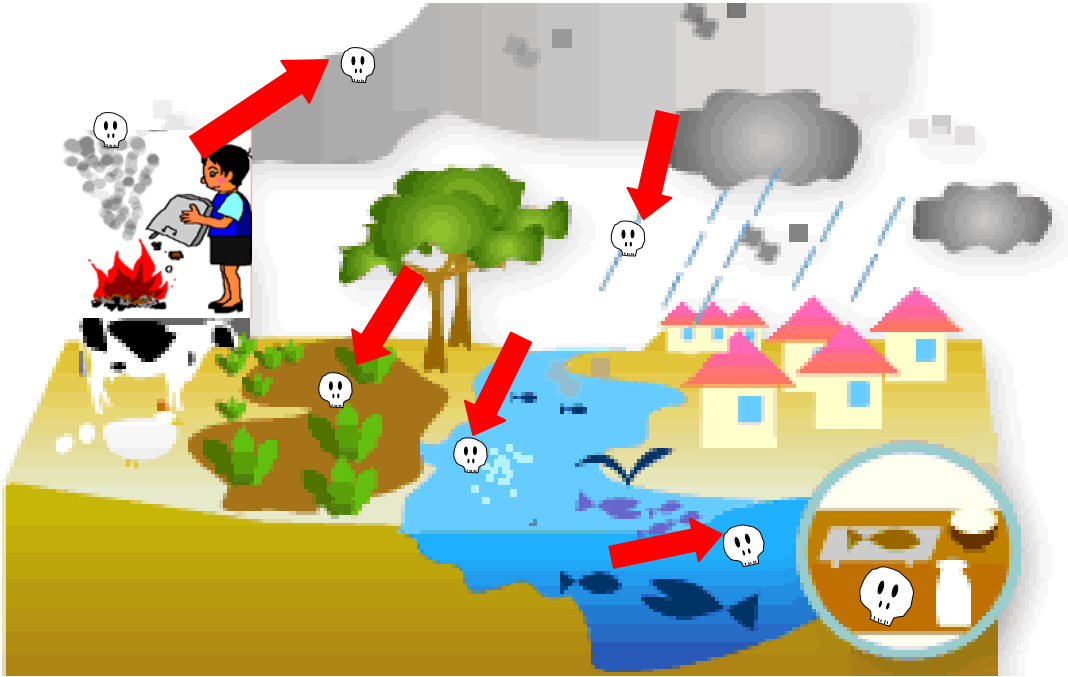
The major source of dioxin in the environment comes from waste-burning incinerators of various sorts and also from backyard [burn-barrels](#). Dioxin pollution is also affiliated with

paper mills which use chlorine bleaching in their process and with the production of

[Polyvinyl Chloride \(PVC\) plastics](#) and with the production of certain chlorinated chemicals

Exposure to dioxin can also cause cancer. In addition to cancer, dioxin is well-known for its ability to damage the immune system and interfere with hormonal systems. Therefore, **stop burning waste.**

**Pathway of Dioxin when burning waste.**



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• Photos & information from Lisa Muranaka: MNRE Waste Management Files.

## YEAR 8

### Activity One: Water Pollution Survey

**AIM:** To carry out a field survey about water pollution.

- Teacher to organise a visit to two areas near the school. If there are no rivers or streams, teacher may create own by making one with an old tub or container and placing various pollutants & animals inside.

**Materials**

- rivers/streams/wells/sea near school or old tub/container
- copy of survey sheet
- wall chart for findings

**Time**

- 2 class periods; survey and analysing results

**What to do**

1. Select a couple of sites for a brief class survey of water pollution.
2. Prepare a worksheet or students to copy one for use in the field. The one below is a suggestion.

Water Pollution Survey		
QUESTIONS	Responses and Observations	
	SITE 1	SITE 2
How does the water look?		
How can you tell that it is polluted?		
What is the source of pollution?		
How does the water feel?		
How much animal life is there?		
What does the air around the water smell like?		
Would you like to swim in this site?		

3. Organise students into groups and explain what needs to be done.
4. Discuss class findings in classroom focusing on the pollutants and what can be done to minimise the problem. Also can include discussion of personal hygiene and health related issues arising from the pollution of water in the village. Write up the activity in notebook.
5. Organise a clean up of the river or stream & make sign boards to keep the river clean.\*

\* Dunne, M. & Wendt, N. (editors) **Environmental Education TEACHERS' MANUAL**. 1997 SPREP

## Activity Two: How to make Recycled Paper

**AIM:** To make recycled paper.

### Materials

- blender
- whole section of newspaper
- 2 ½ single newspaper pages
- 5 cups or 2 litres water
- pan 3 inches or 7.6 cm deep
- piece of screen to fit inside pan
- measuring cup
- flat piece of wood the size of a newspaper's front page
- waxed paper

### Time

- 3 class periods; one to explain and discuss activity and the others for doing the activity.

### What to do

1. Tear the two and a half pages of newspaper into tiny strips.
2. Soak strips in 5 cups of water for 5 minutes.
3. Pour strips and water into blender, cover and blend. Teacher should supervise this step.
4. Pour about 1 inch or 2.5cm of water into the pan.
5. Pour the blended paper pulp into the measuring cup.
6. Put the screen into the pan.
7. Pour one cup (240 ml) of pulp over the screen. Spread the pulp evenly in the water with your fingers. Lift the screen and let the water drain off.
8. Open the newspaper section to the middle. Put the newspaper on a waterproof surface.
9. Place waxed paper in the center of the newspaper. Place the screen with the pulp on the waxed paper, and close the newspaper.
10. Carefully flip over the newspaper section so the screen is on top of the pulp. **THIS STEP IS VERY IMPORTANT.**
11. Place the board on top of the newspaper and press out extra water.
12. Open the newspaper and take out the screen.
13. Leave the newspaper open and let the pulp dry for at least 24 hours.
14. When your paper pulp is dry, peel it off and write on it.

## Activity Three: Waste Management

**AIM:** To find out information about waste management strategies for Samoa.

### Materials

- guest speaker
- wall chart

### Time

- one class period

### What to do

1. Invite a specialist from the Waste Management Division of the MNRE to talk to the class about waste management in Samoa. The specialist should include the following:
  - (i) what waste management is;
  - (ii) why there is a need for waste management in Samoa;
  - (iii) what are the main types of wastes in Samoa;
  - (iv) what is being done in Samoa;
  - (v) how can waste be reduced in Samoa;
  - (vi) what are the common types of pollution in Samoa;
  - (vii) what are some environmental and health problems associated with waste not managed in Samoa; and
  - (viii) any other interesting and useful information for Year 8 students.
2. Students should make brief notes and write a report about the talk. Discuss their findings. They should also ask relevant questions after or during the presentation.
3. Use students' notes and knowledge to form a wall chart for the class about Waste Management in Samoa using the ideas (i) – (viii).

### Following layout plan for disposing of waste for Fukuoka Method at Vaiaata



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Photograph from MNRE Power point presentation



## fact sheet seven: The Three R's of Waste Management

Compared to the lifestyle in the 1970's with less plastic waste and more organic waste, nowadays, more plastic waste, cans, bottles are imported from overseas and people prefer to use these products due to the convenience. However, most of the imported products are Non-Biodegradable waste and end up lying around our islands for long periods of time.. Samoa is an island country and land is limited to dump the waste. The capacity of the Tafaigata landfill was estimated at 30 years, but the landfill has been filled up much faster, and so now the capacity is less than 20 years left! We all generate waste every day, so we need to take action to reduce waste for the future generation.



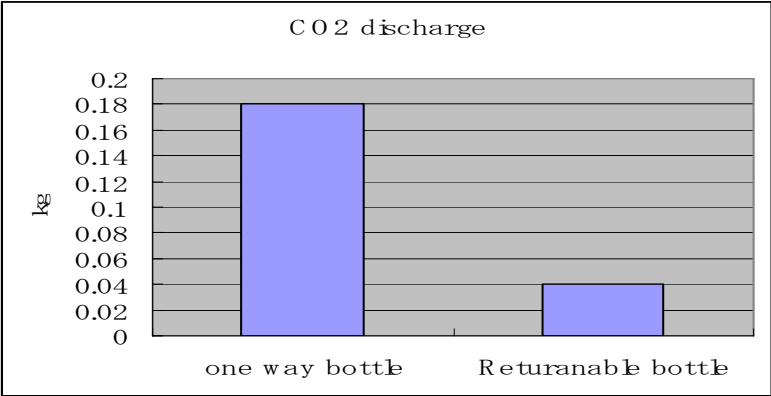
- Reduce:** To make less rubbish from the beginning.
- Reuse:** To use the something several times.
- Recycle:** To remake the waste into new product.

### Reduce

- Bring My Bag for shopping  
(To make one plastic bag, 30g of CO<sub>2</sub> is discharged into air)
- Choose local products instead of imported food  
(local food has less packages than imported food)
- Choose less packaged products
- Buy only what you need
- Make compost from food waste

### Reuse

Use Returnable bottles: Vailima and coca cola bottles are returnable bottles which are rinsed after use and reused again. Returnable bottles produce 4 times less carbon dioxide than one way glass bottle.



Also you can give your used shirt to your other family member, sell old cars, furniture to Reuse!

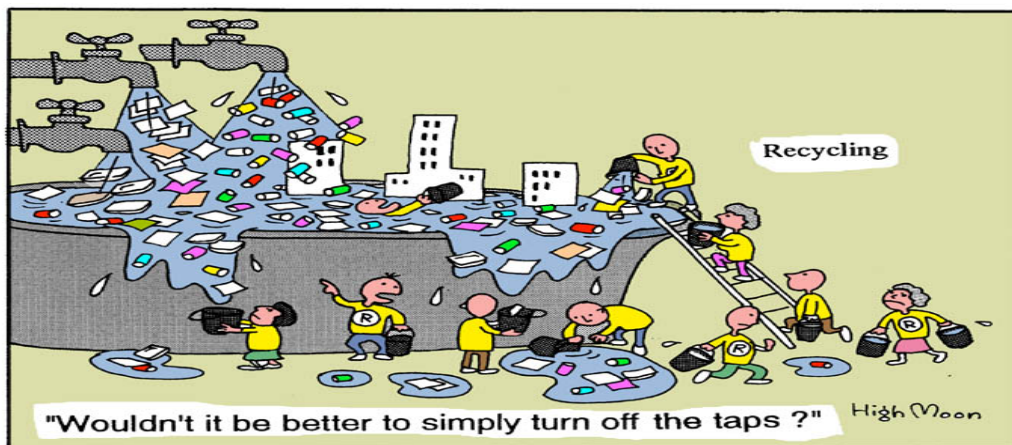
### Recycle

There are Recycling companies in Samoa. The material is sent to NZ, Australia or China to be reproduced to new products.

- Can: can to can
- Paper/ cardboard: paper to paper
- Plastic bottles: to plastic bottle, t-shirt, stationeries, planting containers...
- Metal: metal to metal
- Plastic waste: to plastic products
- Car battery

### Recyclable material in Samoa

Recycling is a smart solution, but transporting recyclable materials and reproducing new products consume a lot of energy. So before recycling, we need to reduce waste first!.



• Information from Lisa Muranaka: MNRE Waste Management Files

## YEAR 9

### Activity One: Composting

**AIM:** To carry out composting.

- Invite a specialist from MNRE or MAFF to talk about composting and to demonstrate how to make compost.

**Materials**

- guest speaker
- materials for compost demonstration – garden fork, old garbage bin, etc.

**Time**

- two class periods

**What to do**

1. Contact specialist about what is needed and organise before the date of the presentation.
2. Students to observe and ask questions. Discuss and explain their responsibilities in maintaining the compost heap.
3. Organise class into groups for doing this work and to start the ‘Making compost in 6 simple steps’ outlined below. This is one way of making compost and it may be different from the one the specialist demonstrated. It is best to locate away from the main school buildings, students and teachers.

Making compost in 6 simple steps

**WHAT TO PUT IN**

Kitchen waste, fish bones, garden waste such as grass cutting, leaves, sawdust, shredded paper, crushed egg and a little soil.

**WHAT TO KEEP OUT**

Meat, grease, fat, dairy products, large bones, food packaging, diseased plant material, noxious weeds, seeds.

**What to do:**

1. Take an old garbage bin, wooden box or just make a compost hole in the ground.
2. Layer your compost with alternate layers of waste and soil. Layers of waste should be no more than 10 cm thick.
3. Alternate layers between garden clippings, soil and vegetable waste.
4. Repeat this layering until the pile is more than 1.5 m high. Do not compact the layers as air needs to circulate freely for composting to take place.
5. Make sure the compost does not become soggy or dry out. Turn it with a garden fork or spade once a week.
6. The compost is ready when it looks like dark soil or potting mix. You can use it in the garden or package it and sell to raise funds.

## Activity Two: Gardening

**AIM:** To use compost & other waste for gardening.

- Teacher may also seek advice from local agricultural extension officer for planting and maintenance of garden. Agricultural Science teacher may also help or contact the Ministry of Agriculture if the need arises.

### Materials

- seedlings or seeds
- gardening tool, plot of land

### Time

- one class period for planning and organizing
- project may run for a term or when harvesting is done

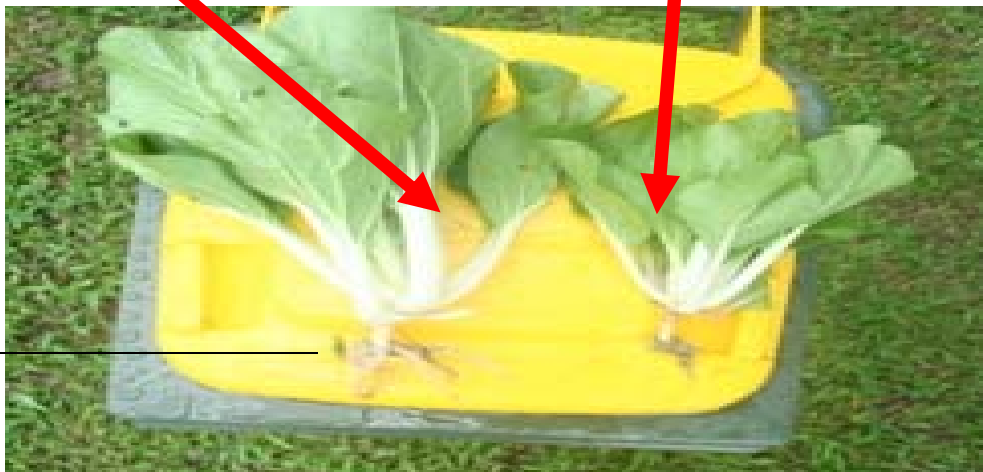
### What to do

1. Discuss with class what they want to grow – flowers, vegetables or both? Discuss the importance of each type of garden. Discuss if you will use fertilisers or pesticides, the advantages and disadvantages of each. Discuss also what you will do with your harvest.
2. Plan your garden making use of your new fertile soil from your compost heap.
3. Organise class into groups that will be responsible for preparing the soil, planting, watering, weeding, composting, accounting, economics and other work necessary. **THIS IS AN IMPORTANT STEP.**
4. Prepare the land and soil for your garden. Make a fence if necessary using whatever materials are readily available at your school.
5. Plant your seeds or seedlings.
6. Make sure your compost heap is renewed to go hand in hand with your garden.
7. Tend your garden well and wait for the results. Happy eating and selling.

### The power of compost

Grown in compost

Grown in soil without compost



Photos from Lisa Muranaka: MNRE Power point presentation – Segregation & Composting

## Activity Three: Home Waste Disposal

**AIM:** To design & carry out a waste disposal strategy at home & school.

### Materials

- newsprint/brown paper

### Time

- one class period to explain and students to design strategy; then check development for a week or a term

### What to do

1. Students are asked to design a waste disposal strategy to use in their homes. They should outline the following:
  - (a) types of waste in their homes – plastics, glass, pampers, food scraps, etc;
  - (b) how they will be collected and stored;
  - (c) how they will be disposed of safely;
  - (d) how they plan to monitor and maintain strategy; and
  - (e) how they will minimise waste in their homes.
2. Work in pairs and compare plans. See if they have the same type of wastes and ideas.
3. Pairs will then present their waste disposal strategy. Discuss with class commenting and improving strategy.
4. Organise class so that the pairs may check the development of these strategies in the homes.
5. Draw a wall chart to monitor the progress of the home waste disposal methods. Discuss the success of the waste disposal strategies and ensuring that it continues. Plan or implement one for your school.

### Collection of waste – Apia main central business area, twice daily



• Sagapolutele, F. Photo from power point presentation **Samoa Waste** 2006 MNRE



## fact sheet eight: Waste Disposal in Samoa

### Waste Disposal in Samoa

In 1992, the Government allowed 100 acres at Tafaigata to be used as the rubbish dump for the island of Upolu. Before that, rubbish was dumped at Vaitoloa and generally anywhere especially the mangroves and the sea. Vaiaata is the chosen site for the waste in the island of Savaii.

Rubbish was collected and dumped on the ground or in a hole stagnates (no air) with leachate (waste water from rubbish) in an anaerobic (no oxygen for respiration) condition. This produces an offensive smell and dirty leachate. It also contributed to global warming by the formation of methane gas, which has 21 times a stronger effect than carbon dioxide. Long-term decomposition is needed under anaerobic conditions before land can be reused.

### **Tafaigata Rubbish Dump – Open Dumping ; Anaerobic Landfill Structure**



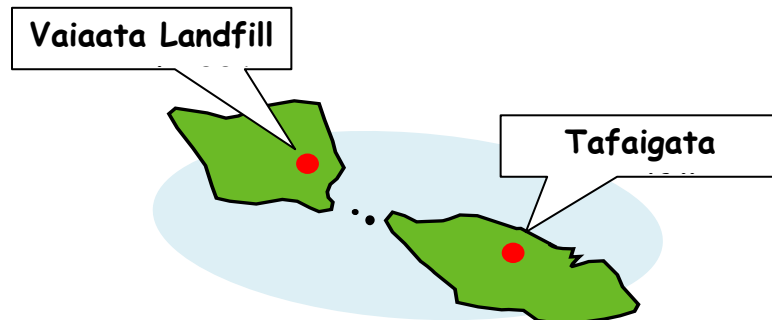
In 2003, work started on a semi-aerobic landfill structure called the Fukuoka Method. Leachate collection and gas venting pipes are set up which provide fresh air automatically into the rubbish layer using convection effect of heat generated by fermentation in the rubbish. This produces less smell and cleaner leachate. The generation of methane gas is low and thus effective for the prevention of global warming. There is easy maintenance and is cost effective using local material such as bamboo, waste tyres, and waste drums as pipes.

### **Tafaigata Rubbish Dump – Fukuoka Method; Semi-Aerobic Landfill Structure**



## Where is your waste disposed?

In Samoa, collected waste is dumped at landfill. There are two landfills in Samoa. Tafaigata landfill in Upolu and Vaiaata landfill in Savaii.



## What is Fukuoka Method?

Tafaigata landfill in Upolu was transformed from a messy and smelly open dump to a clean landfill using **Fukuoka Method**, completed in 2005. The transformation process was funded by Japanese International Cooperation Agency (JICA), at a cost of US\$400,000. Following next year, Vaiaata landfill in Savaii was also implemented Fukuoka Method funded by Government of Samoa at a cost of \$200,000.

Tafaigata landfill is the first landfill implemented Fukuoka method in pacific region and now it became the successful model.



**Open dumping**



**Fukuoka method**

- Photograph from MNRE Power point presentation  
Lisa Muranaka: MNRE Waste Management Files

## YEAR 10

### Activity One: Fukuoka Style

**AIM:** To visit & find out how rubbish is disposed of in Samoa.

Field trip to Tafaigata Rubbish Dump or the Vaiaata Rubbish Dump.

#### Materials

- copy of worksheet
- wall chart

#### Time

- one class period for discussion and making wall chart and half day for field trip

#### What to do

1. Explain to students what they need to find out from the trip.
2. Prepare a Worksheet for the trip. A suggested one is shown below to hand out or students may copy it into their books.

#### WORKSHEET FOR TAFaIGATA OR VAIAATA RUBBISH DUMP

- a. Draw a labelled sketch of the rubbish dump.
  - b. What is the Fukuoka method?
  - c. Is the rubbish sorted at Tafaigata? Explain.
  - d. What will happen when this place is full of rubbish?
  - e. How does the dump affect the local landscape?
  - f. Describe some effects of the dump on the environment?
  - g. Can you recognize some of your rubbish at the dump? Name some of them.
  - h. Is the dump environmentally friendly? Explain.
  - i. Write down any other interesting facts you found out from this trip.
  - j. On the way to the dump, did you notice any other rubbish dumps? Explain.
3. In the classroom, discuss students' responses.
  4. Prepare a wall chart to display students' work.

#### •Tafaigata Landfill – 100 acres of Government land opened in 1992



• Photos from Lisa Muranaka: MNRE Waste Management



## Activity Two: Sewage & Hospital Waste

**AIM:** To find out about sewage & hospital waste.

### Materials

- information on sewage & hospital waste
- specialists to talk about the topics

### Time

- one class period for speakers and 2 for the research & presentations & their own time

### What to do

1. Invite specialists from the relevant departments to talk about sewage and hospital waste:
  - (a) what they are;
  - (b) how they are disposed of safely in Samoa;
  - (c) their effects on the environment and health of the people and other living things.
  - (d) plans for improving disposal of these wastes
2. Organise students into 4 or 5 groups to carry out a research on one of the following topics and present findings to the class:
  - (i) what is sewage ;
  - (ii) what plans Samoa has for sewage treatment;
  - (iii) how sewage is treated in other countries;
  - (iv) what are the effects on the environment when raw sewage is released or leaked from our septic tanks and pipes;
  - (v) what are the types of hospital waste;
  - (vi) how is hospital waste disposed of safely;
  - (vii) what diseases may be caused by these wastes released into the environment.
3. Students will make brief notes for their research. They will participate in discussions during the presentations and ask relevant questions.
4. Discuss findings to enable students to make relevant conclusions and display student work.

### Old burial pit used to dump health care waste before new incinerator installed



• Photograph from Power point presentation by Tesimale Lameko **Health Care Waste**

## **Activity Three: Useful Waste**

**AIM:** To make use of waste material by designing ways of reusing them.

### **Materials**

- waste material: rags/wood/plastic/cans/sacks/paper/etc
- scissors/needles/cotton/dress making materials/carpentry material, etc
- glue/paste/nails

### **Time**

- 3 class periods; 2 to prepare costume and 1 for the fashion show and their own time

### **What to do**

1. Organise class into groups of fours.
2. Each group to make a costume (shirt/skirt/dress/vest/lavalava/etc), furniture or any other useful item using rubbish of any kind.
3. The group will select the person who will model their outfit if it is a costume or just display it if it is something else.
4. When costumes are ready, teacher and class will organise a fashion parade or exhibition to display your creations. You can invite parents or other classes to attend your show and be the judges.

## VI. TOPICS GUIDE CHART

### BIODIVERSITY

Yr	Objectives	Learning Outcomes	Activity description	Curriculum connections	Skills
7	To introduce students to biodiversity.	<ul style="list-style-type: none"> <li>- define biodiversity</li> <li>- identify, name &amp; list plants &amp; animals found</li> <li>- group living things into plants &amp; animals</li> <li>- compare between the two sites visited</li> <li>- describe reasons for the difference in biodiversity</li> </ul>	Walk around school compound and to a river, sea or a forest if one is near to the school.	Science – living things. English – nature exercise. Social Science – Samoan plants & animals. Year 7 Science Book, Unit 1, Unit 2, Unit 3, pgs 1 – 9. <b>Assessment:</b> Group findings from activity.	Observation, writing, communication, grouping, sorting, social, vocabulary.
7	To identify habitats and inhabitants of a seashore community to illustrate marine & terrestrial biodiversity.	<ul style="list-style-type: none"> <li>- define resource, habitat &amp; community</li> <li>- colour picture</li> <li>- answer questions related to organisms &amp; resources provided by the habitat</li> </ul>	Colouring activity with related questions.	Art – colouring Science / English – community study. <b>Assessment:</b> Completion of worksheet.	Colouring, creativity, knowledge, application.
7	To introduce students to conservation in Samoa.	<ul style="list-style-type: none"> <li>- define conservation</li> <li>- state importance of conservation</li> <li>- name organisms that are conserved in Samoa</li> <li>- name places in Samoa where conservation takes place</li> </ul>	Brainstorming activity where students will present what they know about conservation.	English/ Science/ Social Science – conservation. <b>Assessment:</b> Group findings displayed on newsprint.	Drawing, knowledge, values & attitudes, social, communication, writing, oral, vocabulary.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
8	To enable students to carry out interviews to find out about endangered Samoan animals & plants, use their knowledge to create an imaginary animal.	<ul style="list-style-type: none"> <li>- define species &amp; endangered species</li> <li>- conduct interview &amp; collect information</li> <li>- present findings to class</li> <li>- name some endangered species in Samoa</li> <li>- create an imaginary animal that will be able to survive</li> <li>- describe &amp; name ways that affect an organism's survival</li> <li>- describe ways to protect species</li> </ul>	Survey and interviewing elders about species becoming rare & creating a "super" animal.	English/ Science/ Social Science – endangered species. Year 8 Science Book, Unit 3, pgs 7 – 9. <b>Assessment:</b> Listing endangered organisms, creating imaginary species and discussing ideas.	Interview, oral, vocabulary, social, attitudes & values, communication, creativity, drawing, reporting, social, knowledge, application.
8	To improve vocabulary & using words to write about biodiversity.	<ul style="list-style-type: none"> <li>- find words in maze</li> <li>- write sentences using the words</li> </ul>	Word find, vocabulary and sentence writing.	English – vocabulary & writing Science – endangered species. <b>Assessment:</b> Completing word find & sentence writing.	Observation, vocabulary, writing, knowledge.
8	To learn about endangered species of Samoa from experts & to carry out a plant pressing.	<ul style="list-style-type: none"> <li>- listen, take notes &amp; ask questions</li> <li>- name endangered species of Samoa</li> <li>- find information about a plant</li> <li>- carry out a plant pressing</li> </ul>	Specialist talk on endangered species emphasising plants, and a plant pressing.	Science – endangered species, plant study English/ Social Science – endangered species. <b>Assessment:</b> Report writing from guest speaker & plant pressing.	Listening, note taking, communication, knowledge, creativity.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
9	To learn about relationships of members of an ecosystem & appreciate their connections.	<ul style="list-style-type: none"> <li>- define introduced/ invasive species, food chain &amp; ecosystem</li> <li>- name examples of introduced species to Samoa</li> <li>- describe the effects of a named species on a food chain in an ecosystem</li> <li>- identify &amp; describe the roles of various organisms in an ecosystem</li> <li>- construct a food chain</li> </ul>	Classroom activity with students making connections about their roles in an ecosystem.	Science – ecosystem study. Year 9 Science Book 3, Unit 1, pgs 5 – 14. <b>Assessment:</b> Paragraph writing about activity.	Vocabulary, knowledge, communication, oral, social, attitude & values.
9	To identify & explore invasive or introduced species in Samoa.	<ul style="list-style-type: none"> <li>- collect, select, present information</li> <li>- use various sources to collect information; internet, newspapers, magazines, books</li> <li>- describe effects of these species on the environment of Samoa</li> <li>- suggest ways to minimise numbers of these species</li> <li>- give oral presentation of findings to class</li> <li>- answer questions</li> </ul>	Research about an invasive or introduced species in Samoa.	Science – invasive species English – comprehension, essay writing on invasive species. Year 9 Science Book 3, Unit 1, pgs 5 – 14. <b>Assessment:</b> Research information collected & presented to the class.	Research, computer, communication, knowledge, writing, summarising, oral.
9	To play a game illustrating factors that may affect biodiversity.	<ul style="list-style-type: none"> <li>- name &amp; describe threats to species survival &amp; biodiversity</li> <li>- follow instructions</li> <li>- work as a class</li> </ul>	Game activity to illustrate threats to species survival & biodiversity. Students	Science/ Social Science – migration, threats to survival & biodiversity.	Physical, communication, knowledge, calculations, application, competition,

		<ul style="list-style-type: none"> <li>- define immigrant &amp; extinct</li> <li>- describe causes of extinction</li> <li>- calculate percentages</li> <li>- apply game to real situations</li> <li>- run &amp; tag</li> </ul>	migrate from island to island & other students represent the threats.	<p>Maths – calculating percentages.</p> <p>English – essay or paragraph writing on biodiversity.</p> <p><b>Assessment:</b> Discussing factors that may lead to extinction of species.</p>	vocabulary.
Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
10	To learn about quarantine and its role in protecting biodiversity.	<ul style="list-style-type: none"> <li>- define biosecurity &amp; quarantine</li> <li>- name plants &amp; animals not allowed into Samoa</li> <li>- describe the need for biosecurity &amp; quarantine</li> <li>- observe quarantine officers at work</li> <li>- describe programmes carried out by the quarantine office to protect biodiversity in Samoa</li> </ul>	Specialist talk by Quarantine Officer about their role in biosecurity – field trip to airport or wharf if possible to see work in progress.	<p>Science/ Social Science/ English – biosecurity or quarantine.</p> <p><b>Assessment:</b> Completing task sheet.</p>	Vocabulary, listening, communication, oral, questioning, observation, knowledge.
10	To enable students to design questionnaires for surveys to collect information to compare past & present village communities & to predict the future.	<ul style="list-style-type: none"> <li>- draw a map of the village</li> <li>- locate places &amp; name</li> <li>- interview people</li> <li>- develop a questionnaire</li> <li>- compare &amp; contrast</li> <li>- predict future state</li> <li>- apply knowledge</li> </ul>	Drawing sketch maps of the present village or community, compare with elders' maps of the past, and for the students to visualise what the village may look like in the future.	<p>Science – effects of man's activities on environment.</p> <p>Year 10 Science Book 3, Unit 2, pgs 18 – 31.</p> <p>Social Science – map work, survey.</p> <p>Year 10 Social</p>	Drawing, mapping, interview, creativity, knowledge, predicting, work in groups, comparing.

				Science Book 3, Units 2, 3, 4, pgs38 – 95. <b>Assessment:</b> Drawing maps, designing survey questions, analysing responses & thinking of the future.	
Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
10	To demonstrate the sustainable use of resources & conservation.	<ul style="list-style-type: none"> <li>- define renewable &amp; non-renewable resources</li> <li>- name examples of the 2 types of resources</li> <li>- follow instructions</li> <li>- work in groups</li> <li>- tabulate results</li> <li>interpret &amp; explain results</li> <li>- write an essay on how to balance the use of natural resources with conservation</li> <li>- describe sustainable development</li> <li>- apply the activity or game to real life situation</li> <li>- describe ways of reducing wastage of a non-renewable resource</li> </ul>	Game activity to illustrate wise or sustainable use of a non-renewable resource and to promote conservation.	<p>English – conservation Science/ Social Science – conservation, renewable &amp; non-renewable resources, sustainable development.</p> <p><b>Assessment:</b> Discussions arising from the game &amp; essay writing.</p>	Following instructions, group work, comprehension, communication, values & attitudes, knowledge, application, essay writing, recording results, interpreting and analysis of results.

## fact sheet nine: What is Biodiversity?

### **BIODIVERSITY**

The word 'biodiversity' is a contraction of the word 'biological diversity' and refers to variety within the living world. The term is commonly used to describe the number, variety and variability of living organisms. The biological diversity of an area is generally measured in terms of the range of genetic, species and ecosystem diversity it contains. Genetic diversity refers to the heritable variation within and between populations of organisms. Species diversity is used to measure biodiversity. Ecosystem biodiversity refers to the variety of habitats or communities of organisms.

Biodiversity is classified into three main areas:

- (i) terrestrial biodiversity;
- (ii) marine biodiversity;
- (iii) ecosystems (terrestrial & marine).

### **Terrestrial biodiversity**

This covers issues such as: species conservation on land/freshwater; terrestrial conservation areas and protected areas system, community conservation areas for sustainable development; invasive species management, threatened & endangered species (e.g. birds like the Manumea and Maomao); research into biodiversity status of terrestrial species/organisms); and biosecurity to safeguard native terrestrial biodiversity.

### **Marine biodiversity**

This covers issues such as: marine species conservation, marine protected areas (MPAS e.g. Aleipata, Safata); invasive species management, threatened and endangered species.

### **Ecosystems (marine & terrestrial)**

These are communities of plants, animals and microorganisms that interact with each other and with their physical environment. They provide different habitats and different species are found in a marine (e.g. coral reef) and a terrestrial (e.g. rainforest) ecosystem. This covers the issue of the conservation values and benefits of protecting ecosystems in comparison with saving a single species. This also includes what needs to be done to save threatened ecosystems, for example: marine ecosystems would be looking at coral gardening to restore degraded coral reefs; terrestrial ecosystem is looking at replanting of trees or reforestation programmes that could replenish those bared areas that have been logged or left unproductive due to previous agriculture developments.

### **Status of Samoa's Biodiversity**

The South Pacific Biodiversity Conservation Programme recognises Samoa as one of five countries in the programme that are important for their wealth of biodiversity. The flora is one of the most diverse in Polynesia with about a quarter of plant species endemic, that is, they are found nowhere else. The importances of the country's bird life, particularly



the proportion of endemic species (23%), and the threats to it, have been recognised by the International Council for Bird Preservation. They have listed the Samoan Islands as one of the world's 'Endemic Bird Areas' in need of 'urgent' conservation attention.

Samoa's biodiversity is among the richest and diverse of the Polynesian islands. Its species contribute to the maintenance of over 19 terrestrial vegetation types, coral reefs, mangrove forests and sea grass beds. These had provided for all the needs of Samoans in the past.

### Concerns and Priorities

The rich diversity of life in Samoa is threatened through over exploitation and spreading degradations of modern developments. In addition, the increased veracity and frequency of natural disasters with the spread of invasive species. These have escalated the rapid depletion of these resources.

There is a need to increase efforts at regenerating and securing the long-term survival of the remaining habitats and species populations. Various conservation and environment protection programmes have been initiated in the country to address these concerns.

### Conservation in Samoa

This refers to the various programmes for the preservation and sustainable use of biodiversity. These are grouped into eight types: 1) National Parks; 2) Nature Reserves; 3) Managed Watersheds; 4) Traditional Protected Areas; 5) Village Agreements; 6) Fisheries Reserves; 7) Sites of tourism Significance; and 8) Conservation Areas. A national park is a large area where one or more ecosystems that have not been altered or affected by human activities has significant scientific and educational value; is managed by a statutory authority; and can be accessed by visitors and interested parties under strict regulations.

Nature reserves refer to areas on land or sea that are not set aside for any public purpose and made into reserves to protect, conserve and manage plants and animals and their habitats.

Managed watersheds are areas, which are managed to achieve a sufficient supply of good quality water. Conservation areas, village agreements and fisheries reserves refer to conservation programmes managed by village communities. Sites of tourism significance are important historical monuments. Traditional protected areas are sites of both land and sea where villages practice traditional prohibitions on the use of natural resources.

### Conservation Programmes

One of the national parks in Samoa is the 'O le Pupu Pu'e' at Falealili, three new national parks have been approved for Savaii and Lake Lanotoo has also been approved by Government to be declared one. Nature reserves include Palolo Deep at Mataututai,

Tusitala Historic Reserve at Vailima, Head of State's residence at Vailele and Government Prayer House at Mt. Vaea.

Managed watersheds include the Vaisigano and Fuluasou rivers. Efforts are underway to include Faleseela and Falefa rivers in Upolu and Sili and Vailoa I Faliata rivers in Savaii. The Samoa Water Authority was set up in 1994 to oversee the management of water resources in the country.

Conservation areas include the Saanapu – Sataoa mangroves and the Uafato Forest. Moataa mangroves are now also a conservation area. Village agreements are in Savaii at Falealupo, Faala and Tafua – Salelologa for coastal lowland forests and at Aopo for its cloud forests. 56 village fisheries reserves were established and a major marine management programme at the districts of Aleipata and Safata.

More than 20 sites were registered as significant tourism sites. Some examples include the Saleaula lava fields and Mt. Matavanu crater and Pulemelei mound at Vailoa Palauli.

### Community

Populations of plants and animals interacting in an area.

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• Division of Environment & Conservation. **What is Biodiversity? Fact Sheet One.** Biodiversity Section of MNRE, Information Sheet.

**YEAR 7**

**Activity One: Variety of Life**

**AIM:** To observe & list the variety of life in & around the school compound.

**Materials**

- pen & paper
- newsprint/brown paper

**Time**

- one class period

**What to do**

1. Divide the class into groups of fives or sixes. Take class for a walk around the school compound.
2. If school is near to the sea, river, plantation or forest, then take them there after walking and collecting data in the school compound.
3. Each group should write down the names of all living things they find in the school grounds and the sea/river or forest and then return to the classroom.
4. In the classroom, students should group their living things into plants or animals.
5. Ask students if there were many or a few organisms found. Discuss and Explain why.
6. Write the term BIODIVERSITY on the board and explain and discuss with class.
7. Give out newsprint or brown paper to the groups to list their findings like the table outline shown below:

<b>SCHOOL COMPOUND</b>	<b>SEA/FOREST/RIVER</b>
<u>Plants</u>	<u>Plants</u>
<u>Animals</u>	<u>Animals</u>
<b>Total number of plants:</b>	<b>Total number of plants:</b>
<b>Total number of animals:</b>	<b>Total number of animals:</b>
<b>Total biodiversity:</b>	<b>Total biodiversity:</b>

8. Ask students to compare the biodiversity of the two sites and to give reasons for any differences or similarities.

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• Live & Learn Environmental Education. **HOPE Teachers' Guide**. 2006

## Activity Two: Seashore Community

**AIM:** To identify various habitats & organisms in the seashore community.

**Materials**

- colouring pens/crayons
- copy of picture

**Time**

- one class period

**What to do**

1. Colour the picture of the Seashore community below.
2. How many different habitats can you identify?
3. Why are there many different habitats in this community?
4. How does the habitat help the animal or plant (both sea and land plant and animals) survive? What does it provide for the organism?

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## Activity Three: Conservation

**AIM:** To define & find out conservation programmes in Samoa.

### Materials

- wall chart
- newsprint/brown paper
- diagrams/pictures
- markers/crayons

### Time

- 2 class periods; brainstorming and group work

### What to do

1. Prepare a wall chart and write the word CONSERVATION in the middle.
2. Brainstorm with students what they think of the following and discuss:
  - (i) what the term means;
  - (ii) why it is important;
  - (iii) is it practiced in Samoa;
  - (iv) give examples of things that are conserved in Samoa; and
  - (v) where does conservation occur.
3. Using the list of things that are conserved in Samoa, focus on the living things, divide the class into groups and assign each group with an example. (Two groups may share a topic if there are not enough to go around.)
4. Give each group newsprint to present the following information:
  - (i) name of living thing;
  - (ii) why is it important to Samoa;
  - (iii) a diagram or picture of the organism;
  - (iv) how is it being destroyed;
  - (v) what will happen if we do not conserve it; and
  - (vi) how can we help to protect it.
5. Discuss and display group findings.

## fact sheet ten: The need for Biodiversity

### Some reasons People Need Biodiversity

- Food
- Medicine
- Economic opportunities – tourism
- Pollination
- Clean air and water
- Flood and erosion control
- Natural rubbish removal by decomposition
- Spiritual, cultural and aesthetic values – provides inspiration and provokes curiosity and imagination and all species have a right to exist.

### Endangered Species

A species becomes endangered when there is only a few left of its members and are in danger of becoming extinct. Natural disasters might contribute to this but mostly it is due to man's activities.

Animals are more prone to extinction if they:

- (i) are naturally rare;
- (ii) have small ranges, specific food or nesting patterns;
- (iii) migrate;
- (iv) live only on islands;
- (v) are very sensitive to change;
- (vi) produce few offspring and have long gestation periods;
- (vii) are used for food or medicine; and
- (viii) interfere in some ways with people's activities.

Plants are also affected by the above except for (iii) and (vi).

About 136 native species of flowering plants are considered endangered in Samoa. Two species of bats were severely reduced during the two major cyclones of the 90s. 14 bird species are on the endangered list including the Samoan ground dove, Tuaimé'o, and the tooth-billed pigeon, Manumea. The diversity of native and endemic species is threatened by various social and natural developments. Their over-exploitation in inappropriate ways such as the clear felling of native forests, extensive reclamation of mangrove areas and the practice of dynamiting and poisoning for fishing purposes. The introductions of exotic and foreign species alien to the country's biodiversity have severely depleted their populations. Climatic change has also caused degradation of pristine ecosystem conditions, which maintain the continuing survival of species.

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• Division of Environment & Conservation. **Species Management Fact Sheet Three.**

## YEAR 8

### Activity One: Rarely Seen

**AIM:** To promote awareness about organisms rarely seen in Samoa again.

#### Materials

- pen & paper
- newsprint/brown paper

#### Time

- two class periods

#### What to do

1. Ask students to interview elders of their family and village about the following:
  - (i) name an animal or plant that used to be found in large numbers in their youth but are either no longer seen or not often seen;
  - (ii) what was this organism used for;
  - (iii) why has it disappeared or not often seen;
  - (iv) is there a need to try to increase the numbers of this organism and why; and
  - (v) how can we do this?
2. Have students make a list of the species identified.
3. Discuss results of interviews and endangered species.
4. Separate class into groups of fours or fives. Ask them to create an imaginary animal species using the guiding questions below. Use newsprint to write the information about their species and they may draw a diagram of it to present to the class. Present your animal to the class.

#### Describing your species

- Where does it live?
- Does it live alone or in groups?
- Does it like warm or cold weather?
- Does it like hills or flat lands?
- Does it like wet or dry conditions?
- What does it eat?
- How often does it reproduce?
- How many young does it have at once?
- Does it migrate?
- Who are its predators?
- What does it look like?

5. Ask the class after the presentations to decide which of the species would be the first to become extinct as more people move into the area. Give reasons and discuss.\*

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\* Conservation International & World Wildlife Fund. **Exploring Biodiversity: A guide for educators around the world.** 1999

## Activity Two: Word Find

**AIM:** To use the words in the correct context to write sentences about the concepts studied.

**Materials**

- copies of word maze

**Time**

- one class period

**What to do**

1. Find the following words in the grid below by circling the letters. They may be up, down, backwards or diagonal.
2. Use the words below in a sentence related to biodiversity, conservation and endangered species.

**Word List:**

endangered	extinct	conservation
exotic plant	species	Manumea
Mynah bird	cyclone	predator
habitat	exist	exploitation
diverse	save	preserve

N	O	N	E	X	T	I	N	C	T	O	P
M	O	U	N	T	O	N	L	Y	C	A	P
E	D	I	V	E	R	S	E	C	P	E	R
N	O	I	T	A	T	I	O	L	P	X	E
T	F	E	L	A	B	U	T	O	R	I	D
A	L	O	V	E	V	A	S	N	E	S	A
L	E	X	I	L	E	R	L	E	S	T	T
Y	E	N	D	A	N	G	E	R	E	D	O
H	A	B	I	T	A	T	E	S	R	O	R
D	R	I	B	H	A	N	Y	M	V	T	E
S	E	I	C	E	P	S	A	N	E	O	R
E	X	O	T	I	C	P	L	A	N	T	C
Y	O	U	A	E	M	U	N	A	M	I	H



## Activity Three: Plant Pressing

**AIM:** To gather information about endangered species in Samoa & carry out a plant pressing.

Invite a specialist from MNRE to talk about endangered species of Samoa

### Materials

- pen & paper
- leaves
- glue/paste
- markers
- old newspapers
- cardboard

### Time

- one class period for speaker and about a week to dry specimen and another period for presenting pressing

### What to do

1. Invite a specialist to talk about endangered species in Samoa and to emphasise plant species. Students to write a report about the talk.
2. Ask students to identify and select one small herb, weed or plant to press.
3. Show students how to press plant
  - (i) Make sure plant material will fit newspaper length.
  - (ii) If it is a small plant, press the whole plant with roots. If it is a large plant, use a small branch with leaves. If it is a flowering plant, you should include the flower.
  - (iii) Place your plant specimen between newspaper pages. Make sure the leaves and all parts are spread out neatly.
  - (iv) Close newspaper and place heavy books on top.
  - (v) Renew newspaper everyday for a week or until leaf is dry.
4. Paste or glue dried plant onto a piece of cardboard.
5.
  - (i) Write the name of the plant (English or Samoan or both).
  - (ii) Describe the habitat of the plant.
  - (iii) Write a description of the plant.
  - (iv) Write the importance of the plant.
6. Discuss and display student work.

## fact sheet eleven: Biosecurity

### Biosecurity

This refers to the protection of native biodiversity in Samoa from being degraded or altered by the influence of invasive species. Invasive species refers to alien animals and plants species or plants and animals introduced in Samoa from other countries. Biosecurity also refers to the protection of native biodiversity from being replaced or altered by the spread of genetically modified organisms.

### Status of Biosecurity in Samoa

The effect of genetically modified organisms (imported foods, animals and plants), on native biodiversity is largely unknown.

Introduced mammals; rats, pigs, dogs and cats have contributed to declines in native fauna either as predators or competitors.

Many plant weeds have been identified in Samoa, posing a threat to the recovery of the native forests from cyclones and other natural disasters. The following invasive species need more action to contain their spread: fue lautetele (*Merrimia pelata*), fue saina (*Mikania micrantha*), vao migi (*Solanum* sp.), vao lima (*Paspalum conjugatum*), pasture grass (*Ishaemum timoriense*), tamaligi (*Albizia* sp.), pulu vao (*Funtumia elastica*) and pulu mamoe (*Castilla elastica*) are some of them.

The giant African land snail (*Achatina fulica*) threatens both agricultural and natural ecosystems in Samoa. Farmers have made an illegal and inappropriate introduction of a flatworm in an attempt to control this snail and it is likely to have a serious impact on native species. The mynah bird is also another recent threat to our native birds and noise pollution. The flatworm and mynah bird are introduced species for biological purposes, and they have turned out to be pests themselves.

### Priority Issues

The two most important priorities for the security of native biodiversity in Samoa are to :

- Enforce strict bans and quarantine on introduced species and to
- Effectively contain the spread and eradicate where possible, invasive species now in the country.

There is a need to raise awareness and for relevant responsible government agencies and village communities to enforce relevant regulations to improve the elimination of invasive species.

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• Division of Environment & Conservation. **Biosecurity Fact Sheet Five.**

## YEAR 9

### Activity One: Eco-connections

**AIM:** To identify & explain relationships of organisms in the ecosystem.

- Large classes of 30 or more may be divided into two groups to carry out activity.

**Materials**

- 2 balls of string/rope/yarn
- paper & marker

**Time**

- one class period

**What to do**

1. Choose a local ecosystem such as forest, coral reef or mangrove.
2. List the various living and non-living things in that ecosystem. Add to this list an introduced species.
3. Construct a food chain from your list.
4. Assign each student the name of a plant, animal, microorganism or non-living thing in the ecosystem. If there are not enough for the whole class, they can be recorders for the activity and help to set up the activity.
5. Have each student write their assigned name on a piece of paper and tape to the front of their shirts.
6. Students to stand in a circle and explain that together they represent an ecosystem, and each of them represents a part of that ecosystem. (**The introduced or invasive species student should not be included.**) Have them look around and think about how they are all connected.
7. Give the ball of string or yarn (vulu) to one student to hold one end and toss the rest of the ball of string to another student, explaining his or her connection to the other student. For example, the tree student might say he is connected to the bird student as he provides shelter for the bird.
8. Continue this tossing of the string and making the connection. As each student makes a connection, help wrap the rope around the back of each student's waist forming a big complicated shaped web among the students.
9. When the web is formed, explain that harming or disrupting any part of the web can upset the entire web. For example, if the trees were cut down, then the tree students can start to shake, tug string or fall down, what happens? Discuss.
10. Study the food chain that was constructed. Identify those students.
11. Get another ball of string and connect them.
12. The introduced species student should now enter the circle. Ask the students what will happen. Where will it live? What will it eat? Discuss and explain. What happens to the circle connected with string?
13. Students to write a paragraph to explain and describe what they did and learnt.

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• Conservation International & World Wildlife Fund. **Exploring Biodiversity: A guide for educators around the world.** 1999

## Activity Two: Invasive Species

**AIM:** To define & collect information about invasive species in Samoa.

### Materials

- information about invasive species
- paper for wall charts and markers
- scissors, glue, tape

### Time

- 3 class periods

### What to do

1. Explain and discuss invasive species. Name examples in Samoa.
2. Arrange students into groups of fours or fives.
3. Each group will collect information about an invasive or introduced species in Samoa and present this information as a poster or wall chart. Teacher should have the necessary information available if school is far away from town, or inform the students about the places where this information can be obtained; MNRE, SPREP, internet, newspapers, etc. This information should include the following:
  - (i) name of the organism (Samoan, English and scientific);
  - (ii) a picture or diagram of the organism;
  - (iii) how the organism reached Samoa;
  - (iv) effects of this organism on the environment of Samoa; and
  - (v) what can be done to solve the problem.
4. Teacher should allocate an organism for each group to avoid them studying just one invasive species.
5. One period should be used for preparation for the activity, and one week given for group research during their own time. One period should then be given for putting the information together and preparing for the presentation.
6. Groups to present findings to class and discussions of each to follow. Display students' work.

## Activity Three: Immigration

**AIM:** To identify & explain factors that contribute to the survival of a species.

### Materials

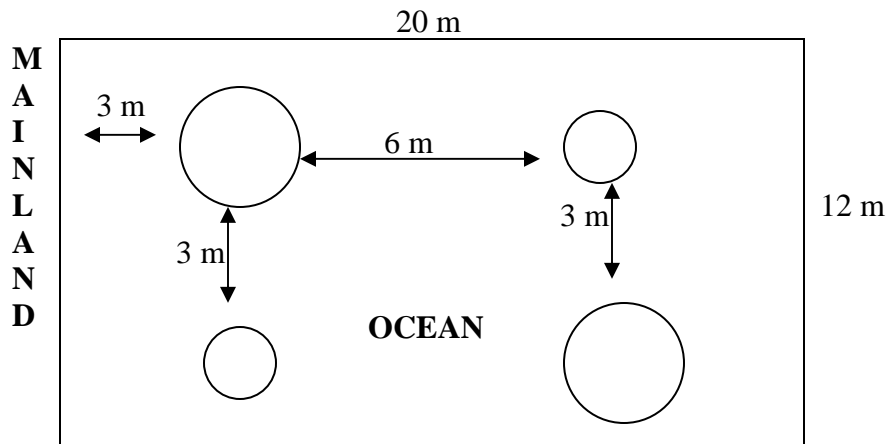
- two 8 metre ropes
- two 12 metre ropes
- metre ruler
- whistle

### Time

- two class periods

### What to do

1. Mark an area in the school fields (about 20 metres by 12 metres) for this activity as shown in the diagram. Students can help to set up the activity.



2. Use two 8 metre ropes or string to make two small islands with diameters of about 2.5 metres.
3. Use two 12 metre ropes to make two large islands with diameters of about 4 metres. Arrange these islands as shown above.
4. Explain the rules of the game to the students.
  - a. There are 4 islands off the mainland.
  - b. Species move from the mainland to the islands and three-quarters of the class will be the species immigrating to the islands. The rest of the class will represent threats that can cause immigrating species to become extinct.
  - c. Discuss some of the causes of extinction – predators, diseases, pollution, severe weather, etc.

- d. Immigrating species will have one minute to run from the mainland to an island, but when they are between islands, they will have to avoid being tagged by the students in the playing area.
  - e. Taggers are to spread out in the ocean (playing area) and make sure they keep moving all the time that the species are immigrating.
  - f. When the teacher gives the signal, species on the mainland should start running to the islands. Remind students that the aim of the game is to get off the mainland and arrive safely at an island. It is up to them when to run but the teacher will only give the signal three times. The other students, the taggers, should run after them and try to tag them.
  - g. Species can be tagged out of the game only when they are out in the open ocean.
  - h. Count the number of immigrating species.
5. Blow a whistle to let students know when to begin to immigrate. Some students may help teacher to monitor the game and spot those that become extinct.
  6. At the end of the first three whistle blows, count the number of animal species on each island. Keep a record of results.
  7. Repeat the game, allowing the taggers and helpers to have a go at immigrating.
  8. At the end, have the students calculate the percentage of species that survived, write a paragraph about the threats to species survival and biodiversity.

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\* Conservation International & World Wildlife Fund. **Exploring Biodiversity: A guide for educators around the world.** 1999

## fact sheet twelve: Biodiversity Conservation

### Biodiversity Conservation

One of the greatest challenges we face in protecting biodiversity is how to balance the needs of the present without jeopardising those of the future. Ensuring the survival of species, genes and ecosystems will require a combination of approaches and the collective thinking of people from all disciplines and backgrounds.

#### **Protecting wild spaces**

Only about five percent of the Earth's land area is designated as parks or reserves and much of that is weakly protected and managed. There is a need to have at least 10 percent of the world's natural area including marine areas, protected for the future.

#### **Is the sustainable obtainable?**

Increasing levels of pollution and consumption of natural resources contribute to biodiversity decline. Using resources and creating waste is a necessary part of life and cannot be avoided! However, decreasing our impact on the planet can ensure humans and other species can co-exist indefinitely. Efforts to achieve sustainability must address not only the conservation of biodiversity and other natural resources, but also issues of economic security and social equity!

#### **Land for the future**

More land must be set aside for wildlife. Establishing or expanding protected areas has been shown to be a very effective way to conserve biodiversity, at least within the boundaries of the protected area!

#### **The corridor connection**

What happens to the plants and animals that are not lucky enough to live within a protected area, need to move to other areas to find food, mates or breeding grounds? In a corridor, conservationists work with landowners to protect the most important land areas between official protected areas.

#### **Bringing back the habitats**

Ecological restoration is the process of returning a damaged ecosystem to a condition as close as possible to what it was before it was disturbed.

#### **Rapid research**

We need to find out more about how species depend on their habitats, how people can manage habitats to ensure healthy populations and which habitats and ecosystems are most at risk. Habitat destruction is occurring so fast that species are disappearing before we even know they exist.

**Legal action**

Most countries have environmental protection laws.

**Conservation biology**

This is a fairly new interdisciplinary science designed to explore human effects on biodiversity and to develop practical solutions to the loss of biodiversity.

**Conservation enterprises**

People harm the environment as they have no other choice in how to earn their living. These enterprises find new ways to generate income for communities while helping to conserve natural habitats. Eco-tourism is one example of a conservation enterprise.

**The corporate connection**

Many corporations and large companies are now integrating the need to protect nature into their decision-making. This is partly due to the desire of the public to use environmentally friendly products.

**Saving seeds**

Gene banks for seeds may help to save rare plants.

**Awareness and involvement**

We can all be involved through our roles as educators, parents, landowners, employers, voters, etc.

**The three C's of Biodiversity Conservation****Compassion**

Need to foster more compassion for other species and respect living systems too complex for us ever to understand fully.

**Connection**

Need to educate ourselves about the connections among all elements of biodiversity.

**Consequences**

Need to come to terms with the consequences of our behaviour for other people and other species.

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• Conservation International & World Wildlife Fund. **Exploring Biodiversity: A guide for educators around the world.** 1999



## YEAR 10

### Activity One: Biosecurity Police Force

**AIM:** To define quarantine & explain its role in protecting biodiversity.

- Field trip to the Quarantine Office at the wharf or airport whichever is near to the school.
- If school is too far away and there are problems, you may invite a specialist from the Quarantine Office to come to your school.
- The advantage of the wharf or airport is that students may see officers at work & their role in biosecurity.

#### Materials

- task sheet

#### Time

- one class period for talk & will have to arrange a proper time for field trip when a ship/boat or plane arrives to coincide with trip

#### What to do

1. Prepare class for the specialist's presentation. Give a brief talk about the topic and write Task Sheet for students to copy if there is no photocopier available.

Teacher needs to inform specialist to give information about the role of the Quarantine Office in biosecurity, give examples of items and living things that are not allowed into the country and why, give examples of objects and organisms that have reached Samoa due to negligence and lack of proper security and the importance of this service. Teacher should also request observation by students as officers carry out their job in clearing and checking passengers' luggage by boat or plane.

2. Students to participate when specialist gives the presentation.

#### Task Sheet

1. What is Quarantine?
2. What is its importance to biodiversity?
3. Name examples of plants and animals that are not allowed into Samoa, and explain why.
4. What happens if a person is caught bringing in these banned items and objects?
5. What needs to be done if you want to bring new species in to Samoa?
6. Describe any awareness methods that the Quarantine Office has carried out in Samoa.
7. Write down any other interesting facts you learnt from this activity.

## Activity Two: Now and Then

**AIM:** To enable students to compare the community in the past to the present & to make predictions for the future.

**Materials**

- newsprint & markers

**Time**

- 2 class periods

**What to do**

1. Write the following list on the blackboard.

Habitat Query

- Where are the streams, ponds and rivers?
- Where is the ocean/forest/mangroves/swamps?
- What areas stay wet part or all of the year (wetlands)?
- Where does your drinking water come from?
- Where does your wastewater go?
- Where do different kinds of plants grow?
- Where do different kinds of animals live?
- Where have humans built things? (roads, buildings, etc)
- Where does your food grow?
- How is the land shaped? High or low? (hills/mountains/flat)

2. Divide the class into groups of fours or fives and each group to have newsprint or large piece of paper and markers or crayons.
3. Each group will work together to create a map of their community/village based on the list above. Students may write in information or draw pictures or symbols.
4. After 20 minutes, groups will share their maps and compare. Discuss and identify the most difficult part of the exercise. They may check the accuracy of their maps.
5. From the discussion, students will then design a list of survey questions to ask their parents or grandparents to gather information about the past. Use the Habitat Query and add further questions like: Are there things you like better about the past? The present? How have things changed?
6. Interview their elders and bring information for group mapping the next day.
7. From their survey/interview responses, groups will now create a map of the past.
8. Compare maps and discuss.
9. Pin there 2 maps on the walls and class to view and compare then and now in your village community.
10. Groups to discuss and write conclusion about the activity. Which is the better community to live in and why?
11. Give for homework, draw a personal map of their vision for the future.\*

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\* Conservation International & World Wildlife Fund. **Exploring Biodiversity: A guide for educators around the world.** 1999

## Activity Three: Thinking about Tomorrow

**AIM:** To promote awareness in the importance of resource use for conservation & biodiversity.

**Materials**

- trays/boxes/containers
- bean seeds/lopa/pulu/pu'a/fetau or any other small, round objects
- watch with second hand/stopwatch, student to be timer

**Time**

- two class periods

**What to do**

1. Arrange class into groups of fives. Each group represents a family.
2. Each group will select a family name to represent them. Four of the group members will represent a generation of the family – a great-grandparent, a grandparent, a parent and a child. The remaining member will be the recorder for group results.
3. Explain activity to the class:
  - (i) Objects (small round seeds or other) used represent a non-renewable resource that their families rely on.
  - (ii) Each family member will have the opportunity to “extract” some of the natural resource (small round objects), using only the tips of two fingers (index and thumb).
  - (iii) Each member will collect the object for ten seconds and place into another container on the table. Objects that fall do not count, they are the wasted resources.
  - (iv) When the ten seconds are up, the recorder will count the number of beans and record the results and the next family member will have their turn.
  - (v) Repeat until all family members have had a turn and the number of objects left on the tray represents the non-renewable resource left for future generations.

**Round 1**

1. Place objects on the trays and place on table for each group to use.
2. Place containers for groups to place their extractions near the tray.
3. Start the activity and record results using the table given. Each group will display results for whole class.

<b>Round 1</b>	<b>Family name: _____</b>
Great-grandparent	Number collected
Grandparent	
Parent	
Children	
Total objects remaining	

## Round 2

1. Place all objects (non-renewable resource) back into the tray.
2. Tell the students that they actually need only 10 of the resource to survive.
3. Repeat the same procedure as in Round 1.
4. Record the results in a table (as for Round 1), and after all family members have had their turn, count how many of the resource are left over for future generations.

## Finishing up

1. Class to display group results.
2. Look at the results for Round 2.
3. How many students were able to extract at least 10 objects? These are the family members who were able to get enough of the natural resource to survive.
4. How many students were not able to extract at least 10 objects? These are the family members who could not get enough of the natural resource to survive.
5. How many got 10 objects or more? These members used more of the natural resource than needed.
6. Discuss results using the following questions:
  - (i) For both rounds, did each successive generation collect more or fewer objects than the previous generation?
  - (ii) Compare the number of objects left over after the first round to the number of the second round. Did one round have more left than the other? Why? (If students were taking only enough to survive, more of the resource should have been left over in Round 2)
  - (iii) Why might a particular generation consume more natural resources than they need?
  - (iv) Are there any reasons a particular generation would want to conserve its natural resources? What is the term for using natural resources in a way that protect them for future generations and other species?
  - (v) Who did not survive? How does it feel? Who got too much of a resource? Did it affect whether the next generation got enough of the resource?
  - (vi) Did either round produce a lot of wasted resources? What could have been done to reduce the amount of wasted resources?
7. Ask students to write an essay on the question of how to balance the use of natural resources with conservation.

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• Conservation International & World Wildlife Fund. **Exploring Biodiversity: A guide for educators around the world.** 1999

## VII. TOPICS GUIDE CHART

### MARINE ECOSYSTEM

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
7	To introduce students to the coral reef.	<ul style="list-style-type: none"> <li>- colour the coral reef diagram</li> <li>- identify some reef organisms &amp; name them</li> <li>- describe uses of organisms</li> <li>- identify the coral reef as providing habitats for many organisms</li> <li>- define habitat</li> </ul>	Colouring activity, identifying some reef organisms, their uses & identifying names.	Art – colouring exercise Science – coral reef habitat. Year 7 Science Book, Units 1, 2, 3, pgs 1 – 9. <b>Assessment:</b> Coloured diagram, definitions, Samoan names & uses of organisms.	Colouring/art, identification, communication, vocabulary.
7	To learn about nutrients in fish & their importance in Samoan diet.	<ul style="list-style-type: none"> <li>- arrange fish parts in puzzle</li> <li>- work in groups</li> <li>- identify parts &amp; functions of fish</li> <li>- colour fish</li> <li>- name nutrients in fish &amp; describe why it is important in the diet</li> <li>- define diet &amp; protein</li> </ul>	Fish puzzle – parts of fish to cut out & arrange, parts & functions.	Home economics – diet, food & nutrients Science – nutrition English – fish activity Art – puzzle & colouring. Year 7 Science Book, Unit 5, pgs 12 – 14. <b>Assessment:</b> Completing fish puzzle, names of parts & functions.	Colouring, knowledge, physical, communication, group work.
7	To carry out observations in the field &	<ul style="list-style-type: none"> <li>- follow instructions &amp; work in a group</li> </ul>	Field trip to the sea to observe	Science – community study. Year 7	Leadership, group work, communication,

	apply to concepts learnt in the classroom.	- observe organisms & parts of the seashore - answer questions in task sheet	organisms & marine habitats.	Science Book, Unit 1, pgs 1 - 3. <b>Assessment:</b> Wall chart with information collected from trip.	recording, observation.
Yr	<b>Objectives</b>	<b>Learning Outcomes</b>	<b>Activity Description</b>	<b>Curriculum Connections</b>	<b>Skills</b>
8	To increase students' knowledge of coral reefs.	- name 3 main types of coral reefs - describe how a reef is formed - describe ways that coral reefs are destroyed Explain importance of coral reefs Describe ways to protect the coral reef	Viewing a video/DVD about coral reefs & answering a task sheet prepared about the material.	Science / English – coral reef Social Science – types of reefs. <b>Assessment:</b> Wall chart & answers to task sheet.	Listening, observation, comprehension, writing, communication.
8	To carry out surveys in the village & community to gather information about marine resources for consumption from the marine ecosystem.	- interview vendors - develop survey questions - work in groups - describe importance of marine resources as a source of food & income - group marine resources into scientific groups - describe size limits relating to marine resources - calculate earnings from fisheries - name & describe ways of fishing: traditional, modern, destructive, environmentally friendly	Field trip to fish market, Fugalei / Salelologa market to survey marine resources sold, their prices & other information.	Science – nutrition Social Science – marine resources, way of life, selling, income, small businesses, marketing, exports / imports. English – visit to the local market. Maths – calculations. Year 8 Science Book, Units 1 & 3, pgs 1 – 3, 7 – 9.	Interviewing, survey, communication, oral, collecting data, analyzing data, formulation conclusions, writing.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
				<b>Assessment:</b> Carrying out survey, analyzing data, discussions, paragraph writing.	
8	To introduce students to song composition using the marine ecosystem as the theme.	<ul style="list-style-type: none"> <li>- sing &amp; compose songs</li> <li>- develop actions for dancing to songs</li> <li>- describe meaning of songs about marine ecosystem</li> <li>- describe importance of marine life to Samoan culture &amp; way of life.</li> </ul>	Learning Samoan songs about the marine ecosystem & resources, their meanings & creating dances to match the songs.	Samoan – songs & dances about the marine ecosystem. Social Science – Samoan culture & the marine ecosystem Music – song writing & composition <b>Assessment:</b> Song composition & singing.	Singing, dancing, communication, values & attitudes, knowledge, language, music, vocabulary, creativity & originality.
9	To learn more about the marine ecosystem.	<ul style="list-style-type: none"> <li>- listen, take notes &amp; ask questions</li> <li>- select information to present to class</li> <li>- describe ciguatera poisoning &amp; its effects</li> <li>- describe how crown of thorns destroy coral reefs</li> <li>- name some seaweeds in Samoa</li> <li>- describe importance of seaweeds in the marine ecosystem</li> <li>- find Samoan proverbs involving</li> </ul>	Specialists from fisheries, MNRE or SPREP to talk about topics: seaweeds, ciguatera poisoning & crown of thorns. Activity for students to look at Samoan proverbs & produce charts for class.	Science – marine ecosystem Samoan – proverbs, usage & how it promotes conservation & resources Social Science – culture & conservation. Year 9 Social Studies Book 1, Unit 3, pgs 35 – 56 <b>Assessment:</b>	Listening, communication, creativity, language, knowledge, group work, application, values & attitudes.

		marine resources & marine ecosystem - use Samoan proverbs correctly - describe ways Samoan culture promotes & destroys marine ecosystem		Posters, wall charts from presentation & homework.	
Yr	<b>Objectives</b>	<b>Learning Outcomes</b>	<b>Activity Description</b>	<b>Curriculum Connections</b>	<b>Skills</b>
9	To act out a coral reef crisis applying knowledge to the situations involved in the role-play.	- follow instructions - describe ways that man is destroying & affecting the coral reef - describe ways to reduce these effects - act & evaluate harmful effects of man's activities - work as a class to carry out activity - write a report about the activity	Coral reef crisis game to illustrate harmful effect of man's activities on coral reefs.	Social Science / Science – coral reef English – role-play or drama Year 9 Science Book 3, Unit 1, pgs 5 – 14, Year 9 Social Studies Book 1, Unit 1 & 5, pgs 5 – 25; 35 -56 <b>Assessment:</b> Acting out the role-play, report writing.	Comprehension , social, physical, values & attitudes, participation, communication, language, reporting.
9	To plan & prepare a meal using marine resources & to recognise the nutrients in these food.	- name marine organisms that we eat - name nutrients in these food sources - describe ways of preparing & cooking these foods. - find recipes for cooking - plan & prepare a meal - define & identify crustacean & mollusk	Identifying marine food, finding recipes & cooking meals.	Home economics – nutrition Science – diet Samoan – Samoan food Year 9 Science Book 3, Unit 1, pgs 5 – 14, Year 9 Science Book 1, Unit 3, pgs 32 – 43. <b>Assessment:</b> Recipes, food preparation.	Knowledge, cooking, creativity, planning, working in groups.



Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
10	To find out by carrying out an experiment the reaction of an acid & a carbonate.	<ul style="list-style-type: none"> <li>- follow instruction.</li> <li>- observe &amp; record results</li> <li>- write a word &amp; balanced chemical equation for the reaction</li> <li>- state the reactants &amp; the products of the reaction</li> <li>- describe the test for carbon dioxide</li> <li>- state the scientific name for coral</li> </ul>	Experiment about the reaction of an acid & a carbonate.	Science – experiment. Year 10 Science Book 2, Units 3 & 5, pgs 35 – 46; 54 – 69. <b>Assessment:</b> Experiment write up including answers to questions.	Communication , comprehension, reporting, observation, writing formulae & equations, balancing equations, using science equipment correctly, drawing, formulating conclusions.
10	To design & plan ways of promoting awareness about conservation of the marine ecosystem.	<ul style="list-style-type: none"> <li>- promote awareness about coral reef by performing a play, composing &amp; singing a song, drawing a poster or saying a speech</li> <li>- work in a group &amp; contribute ideas</li> <li>- evaluate effectiveness of promotion activity</li> <li>- suggest ways to make promotion more effective</li> </ul>	Group work on ways of promoting awareness about the importance of coral reefs & how they can be protected.	Science / Social Science / English – conservation. <b>Assessment:</b> Group presentation.	Creativity, group work, values & attitudes, communication, music, composition, oral, writing, originality, application, leadership.
10	To carry out field tasks & observations & apply to concepts studied.	<ul style="list-style-type: none"> <li>- define pH, adaptation, food chain, food web</li> <li>-construct food chain &amp; web</li> <li>- describe adaptations of organisms</li> <li>- measure temperature &amp; pH</li> <li>- observe, identify &amp; name organisms</li> </ul>	Visit to the seashore to carry out various measurements & observations.	Science – community / animal study. Year 10 Science Book 3, Unit 2, pgs 18 – 31. <b>Assessment:</b> Group results, discussions & presentations.	Observation, measurements, communication, language, drawing, knowledge, application, presentation, oral.

## fact sheet thirteen: Coral Reefs

There is a wide range of interrelated ecosystems in the marine and coastal environment of our Pacific islands – an ecosystem being the collection of different living things and the environment (surroundings) in which they live. These ecosystems can be broadly divided into the following categories:

- Coral reefs
- Beaches and seagrass beds
- Mangroves
- Estuaries
- Lagoons
- Ocean waters

In these ecosystems the organisms are variously adapted to their environment producing a diversity of life. The marine environment is fragile and needs protection. It is important that when we use marine resource we ensure that we use them wisely leaving enough to provide for our needs in the future.

### Coral Reefs

Coral reefs are among the world's largest natural structures and are built by the collective efforts of some of the smallest of creatures, coral polyps, generally less than 1 cm in diameter.

Corals are living animals, which build reefs. Coral reefs are made up of colonies of tiny colourful animals called polyps. A coral polyp is a simple jellyfish-like animal living in a cup of limestone, which it builds. When corals die, the next generation will build onto their skeletons. This is how a reef grows. The structures built by corals provide a home for the coral reef community and food for our families.

### Four common types of coral in Samoa

- Staghorn coral
- Brain coral
- Table coral
- Boulder coral

### Where are coral reefs found?

They are found only in the shallow warm waters of the world and they require

- Annual mean water temperature above 21<sup>0</sup>C for reef growth
- Clear water to allow adequate light to reach the corals; soil washed down from rivers and streams can reduce light or cover the corals
- Firm base to build on
- Stable levels of salt; this is the reason why reefs do not occur near the mouth of rivers
- Low nutrients; large quantities of nutrients allow plants and algae to grow over coral

### Importance of coral reefs

- Form lagoons and safe, sheltered areas where more delicate plants and animals can survive
- Coral skeletons break down over time to form rubble and sand to build up our shorelines and beaches
- Protect our houses, beaches and other coastal areas from large ocean waves during storms and cyclones

### Three types of coral reefs

- Fringing reefs – grow outward from the shores of continental islands. They are close to land and are affected easily by run-off and pollution
- Barrier reefs - surround islands but at a greater distance from the shore and with an intervening lagoon.
- Atolls – reefs that surround a shallow lagoon. Initially form as a fringing reef growing around a volcanic island. Over time, the volcano disappears and the coral keeps growing to meet the sea surface.

### How are coral reefs damaged?

In nature, they are damaged by cyclones and infestation of crown of thorns starfish (alamea).

Ways in which people damage the coral reefs:

- Destructive fishing methods such as dynamite, tuiga, ava niukini and bleach
- Taking too many shellfish/fish disrupts the balance in the reef community. The loss of one important level of the food chain can mean the death of many other organisms
- Anchoring on coral and swinging anchor chains can smash over an acre of coral in a few hours
- Coral walking
- Siltation is a good example of how land-based activities can affect marine life. Clearing of land near rivers and sea can result in soil being washed down from rivers and streams and cover the corals, reducing the amount of light needed for photosynthesis
- Rubbish that cannot rot like plastic can cover up corals and kill them. Lots of rotting rubbish in the water or fertilisers from plantations that wash into the sea will provide nutrients for marine plants that might compete with the coral for sunlight. Pollution from factories and oil/fuel from ships released into the sea will also kill coral

### How can we protect coral reefs?

- Take only what you need and eat what you take
- Avoid using destructive fishing methods
- Avoid building pig pens and toilets on the shoreline
- Tread carefully when walking, swimming, snorkeling and boating on and around coral reefs
- Boat operators should anchor in mud and sand away from live coral
- Return undersized or unwanted fish to the water immediately to minimise injury and damage
- Support and respect Marine Protected Areas and sanctuary areas
- Design more awareness programs to educate the people

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\* SPREP. 1997 PYOCR Campaign. Fact Sheet 14.  
King, M. **From mangroves to coral reefs**. 1996. SPREP

## YEAR 7

### Activity One: Colourful Coral Reef

**AIM:** To state the importance of a coral reef, identify some organisms found there & their uses to Samoans.

**Materials**

- colouring sheet, crayons, colouring pens
- poster of Samoan fishes for identification

**Time**

- one class period

**What to do**

1. Ask students what the importances of coral reefs are. Discuss student responses.
2. Hand out copies of colouring sheet for students to colour. Display work in classroom. Can have a colouring competition.
3. Write down the names of organisms they can identify, what their uses are and find out the Samoan names for some of them.

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## Activity Two: Fish Puzzle

**AIM:** To name parts & functions of a fish.

**Materials**

- fish puzzle parts
- newsprint/cardboard/crayons/colouring pens
- scissors/glue/paste/drawing pins/blu-tack

**Time**

- one class period

**What to do**

1. Ask class if anyone had fish for Sunday to'onai. Name the fish that they ate.
2. Ask class why fish is important in the diet. Discuss & explain nutrients in fish.
3. Arrange class into groups of fours or fives.
4. Hand out copies of fish parts without the names.
5. Groups will cut out parts and arrange the fish on a piece of cardboard or newsprint. Use drawing pins or blu-tack to arrange fish. Be careful not to damage your fish.
6. Compare group puzzles and show students diagram of a basic fish. Discuss and explain structures and functions. Correct arrangement if there are errors.
7. Remove pins/blu-tack and glue your fish onto the cardboard. Colour and display.







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• EQPB Environmental Education Section. **Environmental Education Activities Booklet.**

## Activity Three: Trip to the Sea

**AIM:** To identify the organisms found at the beach, lagoon & coral reef.

### Materials

- task sheet/clip board
- newsprint/brown paper

### Time

- two class periods

### What to do

1. Arrange class into groups of fives. Write instructions on the board for students to copy. Each group to select a leader and a recorder to write their findings.

### Task Sheet

- (i) Identify the main parts of the study area: the beach, the lagoon and the coral reef.
  - (ii) At each of these parts, note the following:
    - plants and animals present
    - is it clean or a lot of rubbish
    - list the types of rubbish found
  - (iii) Is there a lot of fishing at the study area? What type of seafood is mainly caught at the study area?
  - (iv) Would you swim at this beach? Why or why not?
2. In the classroom, students will present and discuss their findings.
  3. Make a wall chart for their results and decorate with drawings of some of the organisms they observed.

## fact sheet fourteen: Fishes

### The Six Senses of Fish

Aquatic animals have senses adapted for seeing, hearing, feeling, tasting and smelling in the water. Fishes have a sixth sense, the remarkable **lateral line**.

#### **Seeing**

Fish have no necks so they cannot turn their heads. Their large round eyes protrude from the sides of their heads giving them a wider field of vision. In the case of crustaceans (lobster, crabs and shrimps) the problem of having no neck is solved by having their eyes on moveable stalks.

#### **Hearing**

Sound travels very well in water (almost 5 times faster than air) and marine animals have many ways of making sounds. Most marine animals have highly sensitive hearing. Some fish like the electric eel, use electrical impulses to locate their food.

#### **Feeling, Touching and Tasting**

Fish have a unique device called a lateral line. This is a row of sensory nerves along each side of their bodies, which are sensitive to movement and pressure changes in the water around them. Sightless fish that live in dark underground caves depend on these lateral lines to find food and to navigate. Many bottom dwellers, which have hard shells; protective spines or tentacles have no need for eyes, but use their sense of touch to find food. The tentacles of anemones and the tube feet of starfish and sea urchins are used to sense food.

#### **Smelling**

Many predators, like sharks and eels use their sense of smell to locate food. Salmon are thought to be able to find their way across hundreds of miles of Open Ocean to their home streams by means of this sense.

### Importance of shape

Body shapes give important clues about where fishes live and how they move.

#### **Fusiform:** the swiftest of all fishes

Powerful tails help them chase prey and avoid predators. Many live in the open ocean and swim continuously, travelling thousands of miles in their lifetime.

**Rod:** elongated, arrow-like fishes

These hunters ambush their prey. They float motionless until a smaller fish swims near, then they lunge out with lightning speed to seize their victim.

**Depressed:** flat, pancake-shaped fishes

Use camouflage instead of speed for survival. They burrow into the sand to escape predators.

**Sphere:** puffers and balloon fishes

When threatened they fill their bodies with water or air, becoming too big to swallow. Some have spines all over their bodies for added protection.

**Ribbon:** snake-like fishes

They are slow swimmers but move easily through cracks and crevices. They hide from predators and ambush prey.

**Compressed:** fishes flattened from side to side

Common on coral reefs, their compressed bodies allow them to make quick sharp turns and dart in and out of hiding places.

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• EQPB Environmental Education Section. **Environmental Education Activities Booklet.**

## Activity One: Coral Reef Audio Visual Material

**AIM:** To use audio visual material to find out information about coral reefs.

### Materials

- A coral reef video
  - Coral Reefs in the South Pacific Handbook
- (Materials are available at SPREP or enquire at MNRE)

### Time

- one class period

### What to do

1. Teacher should view the video first and the handbook for background information.
2. Prepare a task sheet for the students to answer during and after the video. Can include the following:
  - How are reefs formed?
  - What are the three main types of coral reefs?
  - What are some of the sources of pollution and reef damage?
  - What are the effects of pollution on reefs?
  - How can the tourist industry harm the reefs?
  - What are some ways that we can do to prevent the destruction of coral reefs?
3. Show the video to the class.
4. Discuss the questions and make a wall chart for the class using student responses.

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## Activity Two: Marine Resources

**AIM:** To design survey questions, interview people to collect information.

**Note:** This activity is in two parts. If your school can easily go to the Fugalei market, the fish market or Salelologa market, then carry out Part A. If it is not possible, then carry out Part B.

Part A:- Trip to the markets

### Materials

- task sheet
- newsprint/brown paper

### Time

- two class periods (one for trip and other for discussion)

### What to do

1. Prepare students for the excursion. Inform them of what to do and what is expected of them. Teacher should also advise market supervisors about the trip.
  2. Divide class into groups to interview different sellers of marine resources at the fish market and the Fugalei market to avoid repetition. Should include the following:
    - List the marine resources for sale ;
    - Where was the fish caught or marine resource collected? (lagoon, coral reef, beach, open ocean);
    - What is the price of the marine resources for sale;
    - Is there a size limit for the marine resource on sale;
    - How often do the sellers come to the market? (once, twice, all week);
    - Is the marine resource available all year round or is it becoming rare; and
    - Do the sellers eat some of the catch or is it all sold.
  3. In the classroom, all groups will put together their list of marine resources and group them:
    - Plants and animals;
    - Fish, shellfish, others like sea cucumbers, sea urchins;
    - Where they were caught in the marine ecosystem
  4. Discuss the classification of the organisms and where they were caught. Write their findings on newsprint.
  5. Discuss the prices of the resources and relate to how often sellers come to the markets. What will they make in a week? Discuss the income generated and
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the rate they are using the resources. Will there be enough for the next generation?

6. Discuss size limits for the resources. What is the importance of this? Who is responsible for monitoring this? Are there laws and regulations for this?
7. Display all results in the classroom and write a paragraph about the importance of marine resources as a source of food and income and what should be done to protect these resources from running out.

### Part B:- Village Survey

#### **Materials**

- task sheet
- newsprint/brown paper

#### **Time**

- two class periods (one for trip and other for discussion)

#### **What to do**

1. Prepare students for the excursion. Inform them of what to do and what is expected of them.
2. Divide class into groups to interview different parts of the village. There are two parts of the survey questions. The first one is for families that sell marine resources and the second for those that do not. You may use both if a family sells & buys marine resources.

#### Family that sells marine resources

- Does your family catch & sell marine resources?
- List the marine resources;
- Where was the fish caught or marine resource collected? (lagoon, coral reef, beach, open ocean);
- How was the fish caught or marine resource collected?
- What is the price of the marine resources for sale;
- How often do you catch & sell these resources?
- Is the marine resource available all year round or is it becoming rare; and
- Do you eat some of the catch or is it all sold?

#### Family that buys marine resources

- Does your family buy marine resources?
- List the marine resources;
- Where do you buy these and how often do you buy them?
- How much do you pay for these resources?
- Is the price increasing, decreasing or staying the same?
- Is the size of the resource you are buying increasing, decreasing or staying the same throughout the years?

3. In the classroom, all groups will put together their findings and record results on newsprint in the classroom under MARINE RESOURCES SOLD and MARINE RESOURCES BOUGHT.
  - Plants and animals;
  - Fish, shellfish, others like sea cucumbers, sea urchins;
  - Where they were caught in the marine ecosystem;
  - How they were caught.
4. Discuss how the resources were caught. Talk about fishing methods. Are they good for the environment and the resources? Find out about traditional and destructive fishing methods.
5. Discuss the prices of the resources and relate to how often they are sold by the families. What will they make in a week? Discuss the income generated and the rate they are using the resources. Will there be enough for the next generation?
6. Discuss the prices and the money spent by the families that buy the resources. Discuss the importance of the marine resources to the diet & nutrition needs of the families.
8. Display all results in the classroom and write a paragraph about the importance of marine resources as a source of food and income and what should be done to protect these resources from running out.



## Activity Three: Singing & Dancing

**AIM:** To collect Samoan songs about the marine ecosystem & resources & compose their own songs.

### **Materials**

- songs/music/musical instruments/CD or tape players
- newsprint/brown paper

### **Time**

- one class period

### **What to do**

1. Ask students for homework to find out some Samoan songs from their parents and relatives about the marine ecosystem.
2. Teacher should collect some songs about the marine ecosystem and write the words on newsprint. Some examples are: Sua maia le tai e; O le aliao, le matapisu; to name a few.
3. Ask the class for their contributions and discuss the meanings of the songs and the usage of the marine ecosystem.
4. Play some songs if equipment available or teach the song and students to sing and play instruments if available.
5. Divide class into three groups to compose a song about the marine ecosystem, either: the biodiversity; the importance; or ways of protecting them. Give each group an aspect of the marine ecosystem to sing about. The song must have at least 3 verses.
6. May also include dancing and other items to match your singing.

## **fact sheet fifteen: Crown of Thorns & Ciguatera Poisoning**

### Crown-of-thorns (Alamea)

Crown-of-thorns are sea stars or starfish, which eat corals. They crawl across the coral reef and feed on the small animals (polyps), which make up the large blocks and branches of coral.

It is impossible to totally protect the corals against the crown-of-thorns starfish. But, it is possible to take action to keep the numbers of the starfish low and protect most of the corals. One way is to have all fishers collect them whenever they see them. Do not break up or chop up crown-of-thorns in the water to kill them. Each part of the starfish can grow into a whole new animal and dramatically increase their number. The spines of the starfish are poisonous and must be handled with care.

### Ciguatera Poisoning

This is a form of food poisoning involving fish that occurs occasionally in most tropical seas. The poison associated with this type of food poisoning is called “ciguatoxin”. This poison is produced by tiny plants called “dinoflagellates” often found attached to other plants growing in coral reef areas. The poison is first taken in by plant-eating fish and then passed on to larger, predatory fish. As these predatory fish feed, they accumulate the ciguatoxin from their prey in their flesh. The poison does not affect the health of the fish.

Any damage to the coral may cause growth of the poison producing dinoflagellates. The problem may be made worse if nutrient-rich pollution such as sewage is involved. In Samoa, the most commonly ciguateric fish is the red bass (mu), moray eels (pusi), long-nose emperor (filoa) and barracuda (saosao).

Poisonings are more likely:

- after major natural disturbances like cyclones or crown-of-thorns outbreaks;
- after human-induced physical disturbance like construction work, dynamiting, coral harvesting or dredging; or
- in areas where the levels of pollution have caused a major increase in algal growth on reefs.

Symptoms usually begin 1 to 24 hours after ciguateric fish are eaten depending on the amount consumed. May include:

- tingling and numbness often in fingers and toes
- burning sensation or skin pain on contact with cold water
- muscular weakness, headache, fatigue, fainting

### Marine Pollution

This is anything, which degrades or spoils the marine environment. Examples are:

- sewage released into the sea;
- throwing oil, petrol, diesel or kerosene into the sea;
- throwing other chemicals, pesticides or fertilizers into the sea;
- throwing rubbish like plastics;
- silt from rivers reduce the amount of sunlight that reaches marine fish and kills fish by damaging their gills; and
- batteries leaking chemicals into the water.

Problems caused by marine pollution will kill or injure some of the organisms:

- oil can cover the surface of corals exposed, gills of fish and plankton and fish eggs
- oil on bird feathers destroys their natural insulation
- heavy metals from batteries and pesticides leak into sea and accumulate in the tissue of animals. This makes them sick or bad for people to eat, e.g. oysters or mussels
- fertilizers and sewage can cause algae to grow quickly and spoil a coastal area. Sewage causes increased algal growth, reduces oxygen in the water, kill fish and increases growth of bacteria (pathogens).

Many countries have strict rules banning all forms of marine pollution. In Samoa, many villages have taken steps to reduce marine pollution especially with the growth of the tourism industry. Many projects and programmes have been held to clean up the beaches and villages. Perhaps the most important thing to do is to teach and educate our children about the effects of dumping rubbish and other forms of marine pollution. <sup>2</sup>

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• M.King & E.Ropeti. **Crown-of-thorns**. Information Sheet 4, 1996.  
P.Matthew & C.Reynolds. **Ciguatera Poisoning**. Information Sheet 5, 1996  
P. Matthew & M.Lafaele. **Marine Pollution**. Information Sheet 16, 1996. Ministry of Agriculture, Forests, Fisheries and Meteorology.

## YEAR 9

### Activity One: Specialist Talk

**AIM:** To find out more about the marine ecosystem & Samoan proverbs associated with the marine environment.

- Invite a specialist from MNRE, SPREP or Fisheries Department to talk about crown-of-thorns, ciguatera poisoning and seaweeds

#### Materials

- guest speaker
- newsprint/markers

#### Time

- two class periods (presentation & follow up)

#### What to do

1. Inform students of activity and what they are supposed to do – listen, participate and make notes. Divide class into 3 groups and assign a topic of the 3 that will be covered for them to concentrate on.
2. Specialist presentation with discussions.
3. After the presentation, the groups will work on their given topics to make posters or wall charts for the class. (If there is not enough time, there is an extra period for the activity.)
4. Give homework for the class:
  - Find out a Samoan proverb that mentions the crown-of-thorns (alamea);
  - What is the meaning of this proverb and when and where is it applied in the Samoan culture?
5. Finish group work and display. Discuss the significance of the three topics studied: crown-of-thorns and destruction of coral reefs; ciguatera poisoning and impacts on our health; causes of ciguatera poisoning and our associated activities; role of seaweeds as producers and the beginning of the marine food chain.
6. Discuss and explain homework relating the Samoan culture and its contribution to the destruction and the protection of the marine ecosystem.

## Activity Two: Coral Reef Crisis

**AIM:** To perform & act out a role play about man's harmful effects on the coral reef.

- Activity should be done outside and preferably the end of the day as some students may get powdered with flour.

### Materials

- large piece of cloth or bed sheet
- metre ruler/stick
- 2m rope or string
- ball, flour, flowers/leaves

### Time

- two class periods

### What to do

1. Divide class into three groups. Half the class will represent the coral. A quarter will be the fish and other marine organisms and the other quarter will be the villagers who use and live by the reef.
2. The coral students should form a group together. They should spread their arms like branches of coral and cannot move as they represent the reef. There should be enough room for other students to move around among them.
3. The fish and other marine organisms should each have a different flower or leaf to put behind their ears to represent the biodiversity of the marine ecosystem. They move in with the coral and "swim" wherever they like but they cannot leave the reef.
4. The villagers stand in a circle about a metre from the outside of the reef. Select students to play each of the following roles:
  - one shell collector who uses a bush knife to break open the coral. Student is given a metre ruler or stick with 2m of rope or string tied in the middle to represent the knife.
  - two village children who walk on and break the live coral. They are given a ball.
  - four villagers who have cleared all the trees and plants off their land and allowed the soil to wash away into the ocean and cover the coral. They are given a large cloth or bed sheet for soil.
  - one farmer who uses chemicals on his farm that are washed into the coral when it rains. Give him a handful of flour for his chemicals.
  - one fisherman that uses chemicals to kill fish. Student will also use flour.
5. Begin with the shell collector. Gently toss the metre ruler or stick with rope into the middle of the coral, while holding on to the other end. Student will slowly pull the rope with the stick tied to it. Any coral or marine organism dragged along with the stick is killed and will move out of the reef.

6. Count how many are killed and how many are left on the reef. Discuss what has happened in terms of human activity, effect and how to avoid the action.
7. Let the coral and other organisms return to the reef.
8. Have the two children have a turn each at gently tossing the ball into the reef. Again, any coral or other organism touched by the ball is killed and moves out.
9. Repeat Steps 6 and 7.
10. Have the four villagers each hold a part of the cloth or bed sheet. Toss it over the reef. Any coral caught beneath the cloth is killed.
11. Ask student what happens to the sea after heavy rains. Discuss the seas being dirty and brown and relate to deforestation and clearing land.
12. Give the farmer and fisherman who use chemicals a handful of flour. Toss the flour into the reef. Any coral or organism powdered with the flour is killed or damaged.
13. Repeat Steps 6 and 7.
14. Students to write a report about the activity. They should include the following:
  - Describe the five ways that humans destroy the marine ecosystem;
  - Describe the effects of these activities on the marine ecosystem;
  - Suggest ways of solving these problems; and
  - What will happen if two or three of these harmful activities occur at the same time?

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• Ricks, K. **Environmental Activities for Primary Schools in Tonga – A Teacher’s Resource Book.**  
1995 SPREP

## Activity Three: Marine Food

**AIM:** To plan & prepare a meal using marine resources.

### Materials

- posters/information about nutrients present in food
- newsprint/brown paper
- food items/cooking facilities

### Time

- two class periods

### What to do

1. Brainstorm with class the different marine organisms that we eat.
2. Divide class into groups of fours or fives. Each group will select and name a plant, a fish and a crustacean/mollusc/or other type of organism from the list. (It is okay if they all have the same plant but the other two must be different for all groups.)
3. Give each group newsprint to write their findings.
4. Find out and list the nutrients that are present in these three marine food and their importance to our diet.
5. Discuss and list the different ways of preparing your three organisms. For example; fish may be raw fish, fish curry, sweet & sour fish, etc.
6. Ask your families for recipes for cooking these resources.
7. Plan a meal of marine resources for your class to celebrate World Food Day or Environment Day.
8. Organise with Food and Textiles or Home Economics teacher your menu and plan.
9. Prepare your food and enjoy the marine resources.

## fact sheet sixteen: Seaweed

### Seaweed

This is the name given for the many types of non-flowering marine plants. They are important for several reasons:

- they provide homes and protection for some animals;
- they provide food for animals and people;
- they take nutrients out of the seawater;
- some of the red seaweeds are very important in cementing together coral reefs; and
- after seaweed has washed up onto the beach, it can easily be collected and used in gardens as fertiliser or compost.

### Increased growth of seaweed

A sudden increase of seaweed means that the system is out of balance. An increase in growth can mean that there is pollution in an area, and fast growth is due to increased nutrient levels. It may also indicate that there has been some damage and recovery has begun.

High levels of nutrients can occur in a number of ways:

- sewage;
- fertiliser; and
- rotting or decaying matter such as leaves or animal flesh

Where seaweed has grown excessively, it can make too much shade, which is no good for coral or clams. Another problem is reduction of habitat.

### Types of seaweed

The most common brown seaweeds that occur in Samoa are *Turbinaria*, *Sargassum* and *Padina*. The green alga that is eaten is *Caulerpa* or limu fuafua. *Gracilaria* is red seaweed that is also eaten in Samoa.

\* P. Matthew & M. Lafaele. **Seaweed**. Information Sheet 17, 1997 Fisheries Division, Ministry of Agriculture, Forests, Fisheries & Meteorology.



## YEAR 10

### Activity One: Acid + Carbonate

**AIM:** To observe the reaction of an acid and a carbonate.

#### Materials

- dead coral pieces (from the beach)
- dilute hydrochloric acid
- test tube
- matches

#### Time

- one class period

#### What to do

1. Crush the coral pieces (dry) and place in a test tube (1 to 2 cm).
2. Add about 5 mls of dilute hydrochloric acid.
3. Hold a burning match over the mouth of a test tube and observe what happens.
4. Write up your lab in the standard scientific format. Include the following questions in your results.

#### Questions

- a. Coral rock consists mainly of calcium carbonate. What is the gas released in the reaction?
- b. What happened to the burning match? Explain why this occurred.
- c. How else can we test for the presence of this gas? What will be the result of the test?
- d. Write a word equation for the reaction.
- e. Write a balanced chemical equation for the reaction.

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• Dunne, M. & Wendt, N. (editors) **Environmental Education TEACHERS' MANUAL**. 1997 SPREP

## Activity Two: Save the Coral Reef

**AIM:** To promote awareness about conservation of the marine ecosystem.

### **Materials**

- musical instruments
- newsprint/brown paper

### **Time**

- two class periods

### **What to do**

1. Divide the class into 4 groups.
2. Each group will design a way of promoting awareness about the importance of the coral reef and saving the coral reef from destruction. This will be in the form of a **poster**, a **song**, a **role play/drama** or a **speech**. Allocate to each group one of the above mentioned forms.
3. Groups will then discuss and plan their presentations. Work on their production for one period.
4. Present work to the class and discuss each groups' work.
  - What are the facts presented;
  - Is it effective if presented to the public: why or why not;
  - What are some of the problems with the method presented by the group;
  - How can the method be improved;
5. Class to decide which group had the best presentation and display work done.

## Activity Three: Marine Ecosystem

**AIM:** To carry out field tasks & observations related to concepts studied.

### Materials

- metre ruler/sticks
- thermometer, litmus paper/universal indicator

### Time

- two class periods

### What to do

1. Divide class into four groups. Hand out Task Sheet for activity.
2. At the seashore, allocate a particular area of the beach where each group will start going outwards to sea. Have groups about 10 metres apart.
3. Each group will then proceed using their Task Sheet as a guide for what they are supposed to do.
4. Collect all data to put together in classroom.

### Marine Ecosystem Task Sheet

1. Start at the beach. Use some sticks to mark an area of 5 metres by 5 metres as your study area.
  - a. What type of sand is found on this beach?
  - b. List all organisms you find on the beach using the following table.

Name	Plant or animal	Habitat	Number present (a lot/few)

- c. Are there any signs of pollution? Describe.
  - d. Draw one organism from your list. Label your diagram.
  - e. Describe two adaptations of your organism.
  - f. Describe the role of your organism in the ecosystem. Is it a producer, consumer or decomposer?
  - g. Classify your organism. Invertebrate/vertebrate; mollusc, etc
2. Using a metre ruler or stick, measure 10 metres and walk towards the sea.
    - a. Mark another area of 5m by 5m as your study area.

- b. Describe your study area. Is it the same as the beach or is it covered by water? Measure the depth of the water.
- c. Measure the temperature of the water. Measure the pH.
- d. List all organisms you find on the beach using the following table.

Name	Plant or animal	Habitat	Number present (a lot/few)

- e. Are there any signs of pollution? Describe.
  - f. Draw one organism from your list. Label your diagram. This should be a different organism from the one you selected before.
  - g. Describe two adaptations of your organism.
  - h. Describe the role of your organism in the ecosystem. Is it a producer, consumer or decomposer?
  - i. Classify your organism. Invertebrate/vertebrate; mollusc, etc
3. Repeat all of **step number 2** two more times.
  4. Record all your group results for use in the classroom.

Finishing up in the Classroom

1. Sketch a diagram of the area covered by the students at the seashore on newsprint and pin on the board.
2. Each group will then write the list of organisms they found. First group will write theirs and the others to add on any new organisms they found at a particular area.
3. Discuss the results looking at the numbers of organisms found and the variety.
4. Discuss signs of pollution and the levels at the different areas.
5. Discuss temperature, pH at the different areas.
6. Discuss the interrelationships of organisms found at the seashore ecosystem. Were any organisms found at a particular area and not in others. Discuss food chains and food webs from the list of organisms.
7. Groups will then present their 4 organisms they selected at the different study areas. Discuss adaptations and roles of organisms in the ecosystem.

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• Dunne, M. & Wendt, N. (editors) **Environmental Education TEACHERS' MANUAL**. 1997 SPREP

**VIII. TOPICS GUIDE CHART**  
**WATER RESOURCES**

Yr	Objectives	Learning Outcomes	Activity description	Curriculum connection	Skills
7	To explain the water cycle by identifying the processes involved and to carry out an experiment.	<ul style="list-style-type: none"> <li>- draw &amp; describe the steps in the water cycle</li> <li>- define the terms: photosynthesis, absorption, transpiration</li> <li>- carry out the experiment by following instructions</li> <li>- observe results &amp; record them</li> <li>- write up the experiment</li> <li>- draw diagram of experiment</li> <li>- apply knowledge &amp; answer questions</li> </ul>	Review of water cycle using Science notes and carrying out an experiment to connect transpiration to the water cycle.	Science – water cycle & transpiration. Year 7 Science Book, Unit 8, pgs 21 – 23. <b>Assessment:</b> Participation in drawing of cycle, experiment write up with answers to questions.	Knowledge, application, comprehension, communication , using apparatus, drawing diagrams, vocabulary, observation.
7	To use science apparatus & read measurements correctly and to carry out simple calculations.	<ul style="list-style-type: none"> <li>- measure volume using measuring cylinder</li> <li>- calculate percentages</li> <li>- draw pie graph</li> <li>- see amount of each type of water</li> <li>- define ground water, surface water, frozen freshwater</li> <li>- work in groups</li> </ul>	Measuring and calculation activity to illustrate the amount & type of water in the earth.	Science – experiment to illustrate water composition, using apparatus for measuring, calculations. Maths/ Social Science – percentages calculations, pie graph drawing. <b>Assessment:</b> Calculations of percentages, pie charts.	Measuring, using science gear, calculation, drawing pie graphs, formulating conclusions, vocabulary, oral, communication , comprehension.
7	To carry out an inventory & to answer a questionnaire at home.	<ul style="list-style-type: none"> <li>- answer the questions</li> <li>- measure amount of water wasted by a leaking tap</li> <li>- calculate amount wasted in a day</li> <li>- describe ways to conserve water by wise use in the home</li> <li>- describe ways that water is wasted in the home</li> </ul>	Water inventory – students have a list of questions to answer about water usage & wastage in their homes.	Science/ English – using water wisely, water wastage. <b>Assessment:</b> Questionnaire Paragraph writing.	Comprehension , observation, calculation, writing, reporting, knowledge.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
8	To use science apparatus correctly, read measurements correctly	<ul style="list-style-type: none"> <li>- follow instructions</li> <li>- use measuring cylinder, thermometer and timer</li> <li>- read measurements</li> <li>- use correct units</li> <li>- define &amp; observe condensation</li> <li>- write up lab in correct standard format</li> <li>- write an aim &amp; conclusion</li> <li>- draw a line graph</li> </ul>	Experiment on boiling two different volumes of water, boiling point of water & demonstrating condensation.	Science – experiment. Year 8 Science Book, Unit 8, pgs 22 – 24. <b>Assessment:</b> Experiment write up including answers to questions.	Observation, measuring, tabulating results, graphing, reporting, following instructions, communication, language & vocabulary, using apparatus.
8	To introduce students to planning, creating & producing a television commercial promoting awareness about water resources.	<ul style="list-style-type: none"> <li>- plan, design &amp; produce a television commercial about water resources</li> <li>- define water resource</li> <li>- work in a group</li> </ul>	Television commercial about water resources – conservation, pollution, quality, awareness/ promotion, wise usage, water bills, etc.	English – media Science/ Social Science – water resources, conservation <b>Assessment:</b> Television commercial.	Creativity, attitude & values, social, group work, originality, language, vocabulary, communication, presentation.
8	To learn from specialist about health & hygiene related to water issues & create posters & signs promoting awareness about water resources.	<ul style="list-style-type: none"> <li>- listen, select &amp; process information</li> <li>- ask relevant &amp; appropriate questions</li> <li>- describe diseases related to water issues</li> <li>- describe good hygiene practices related to water issues</li> <li>- describe ways to improve water quality at home when problems arise</li> <li>- know who to contact when problems arise</li> <li>- design &amp; produce awareness posters &amp; signs &amp; relate to television commercial activity</li> </ul>	Specialist from Ministry of Health to talk about health & hygiene related to water issues & waterborne diseases common in the Pacific and Samoa especially typhoid. Apply this knowledge to produce awareness material.	Science/ Health – diseases, hygiene Social Science – water & health of a community. Art – producing signs, posters, etc. Year 8 Science Book, Unit 3, pgs 7 – 9. <b>Assessment:</b> Information from talk on newsprint, awareness posters & signs, discussions.	Listening, reporting, asking questions, communication, vocabulary, knowledge, creativity, originality, art, application.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
9	To carry out a research using various sources to find information about scientific methods used in water treatment.	<ul style="list-style-type: none"> <li>- define mixture, desalination &amp; sewage</li> <li>- name &amp; describe ways of separating mixtures</li> <li>- describe desalination, water treatment, sewage treatment</li> <li>- collect, process &amp; present relevant, appropriate information</li> <li>- work in &amp; as a group</li> <li>- present findings</li> </ul>	Research on how methods of separating mixtures are used in desalinisation, water & sewage treatment.	<p>Science – water resources, research on topics, application or extension of separating mixtures.</p> <p>English – a project on a topic</p> <p>Social Science – water and quality of life project.</p> <p>Year 9 Science Book 2, Unit 1, pgs 5 – 17.</p> <p><b>Assessment:</b> Wall chart and presentation.</p>	Vocabulary, research, computer, reading, reporting, knowledge, social, critical thinking, group work, drawing diagrams.
9	To visit actual sites to see how water gets to the taps at home & school.	<ul style="list-style-type: none"> <li>- see &amp; describe how water is received at school or home</li> <li>- describe work &amp; function of the SWA</li> <li>- describe what happens to the water we drink</li> <li>- describe how we affect our water supplies by activities at home</li> <li>- describe ways of conserving water</li> </ul>	Visit to the Samoa Water Authority or invite a specialist if it is too far to travel to talk about their work at the SWA.	<p>Science/ Social Science – water resources. Year 9 Social Studies Book 1, Unit 1, pgs 5 – 25.</p> <p><b>Assessment:</b> Report of the visit, answers to questionnaire, discussions.</p>	Listening, observation, recording information, communication, values & attitudes, decision making.
9	To produce a water newsletter or newspaper promoting awareness of water resources in the school..	<ul style="list-style-type: none"> <li>- produce a newspaper or newsletter</li> <li>- learn facts about water &amp; water issues in Samoa</li> <li>- describe functions of different people involved in production of a newspaper</li> </ul>	Producing a Water Newsletter or Newspaper for the school.	<p>English – media</p> <p>Science – water information as a class project</p> <p>Social Science/ Home economics – water for life activity.</p> <p><b>Assessment:</b> Newsletter or newspaper.</p>	Creativity, group work, designing, reporting, writing, communication, attitudes & values, computer, originality, leadership, vocabulary, language.

Yr	Objectives	Learning Outcomes	Activity Description	Curriculum Connections	Skills
10	To find out about water resources & their importance in the Samoan way of life.	<ul style="list-style-type: none"> <li>- find &amp; learn of a Samoan legend or village name origin</li> <li>- learn how water is related to Samoan life in the past &amp; how it will affect the future</li> <li>- describe status of water resource</li> </ul>	Research of Samoan legends or tales, Samoan village names that have “vai” in them or originates from water.	English/ Samoan – legends or myths, origins of villages. Social Science – Samoan villages and legends. <b>Assessment:</b> Information collected and presented.	Language, research, communication, vocabulary, values & attitudes, interview.
10	To use scientific apparatus correctly to carry out an experiment.	<ul style="list-style-type: none"> <li>- define pH, acidic, basic &amp; neutral</li> <li>- use pH paper &amp; universal indicator</li> <li>- describe activities that can alter the pH of water</li> <li>- describe ways to ensure pH is not changed</li> </ul>	pH experiment with various solutions & water	Science – experiment on pH, water pH. Year 10 Science Book 2, Unit 3, pgs 35 – 46. <b>Assessment:</b> Experiment write up.	Experiment, observation, handling apparatus, formulating conclusions
10	To enable students to be creative & original and use artistic talent and work together to promote water resources in Samoa.	<ul style="list-style-type: none"> <li>- define mural &amp; state what it is used for</li> <li>- plan, design &amp; produce mural</li> <li>- participate in class work</li> <li>- draw diagrams or pictures</li> <li>- apply knowledge about water to the mural</li> </ul>	Painting a mural as a class activity.	Art – mural painting Science – conservation. <b>Assessment:</b> Mural.	Creativity, originality, painting, drawing, group work, leadership, organising.



## fact sheet seventeen: Earth's Water

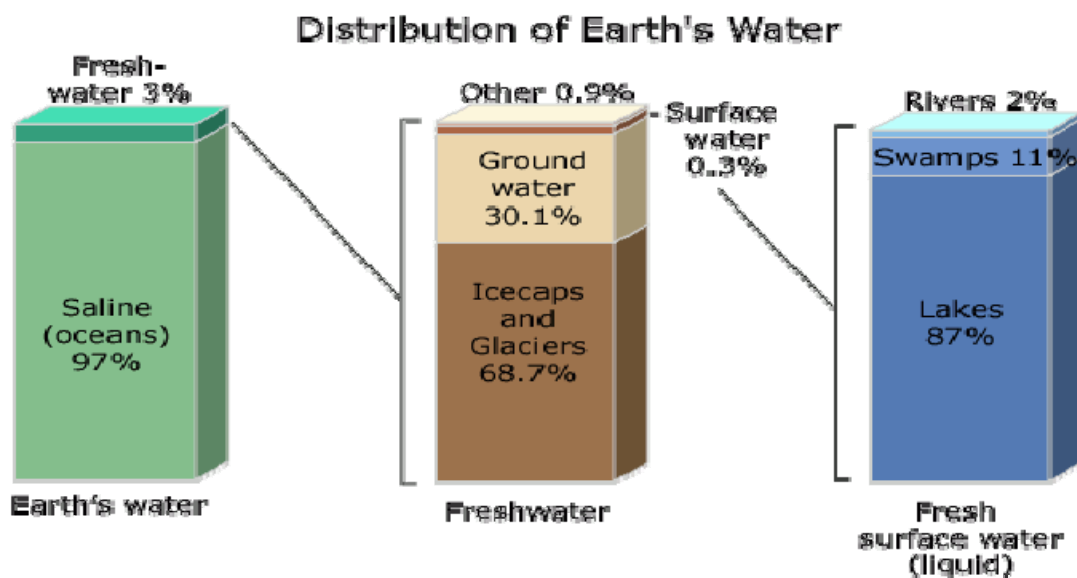
### WATER RESOURCES

Where is Earth's water located?

Water is continually moving around, through, and above the Earth as water vapor, liquid water, and ice. In fact, water is continually changing its form. The Earth is pretty much a "closed system," like a terrarium. That means that the Earth neither, as a whole, gains nor loses much matter, including water. Although some matter, such as meteors from outer space, are captured by Earth, very little of Earth's substances escape into outer space. This is certainly true about water. This means that the same water that existed on Earth millions of years ago is still here. Thanks to the water cycle, the same water is continually being recycled all around the globe.

Water on and in the Earth

Where is Earth's water located and in what forms does it exist? You can see how water is distributed by viewing these bar charts. The left-side bar shows where the water on Earth exists; about 97 percent of all water is in the oceans. The middle bar shows the distribution of that three percent of all Earth's water that is freshwater. The majority, about 69 percent, is locked up in glaciers and icecaps, mainly in Greenland and Antarctica. You might be surprised that of the remaining freshwater, almost all of it is below your feet, as ground water. No matter where on Earth you are standing, chances are that, at some depth, the ground below you is saturated with water. Of all the freshwater on Earth, only about 0.3 percent is contained in rivers and lakes—yet rivers and lakes are not only the water we are most familiar with, it is also where most of the water we use in our everyday lives exists.

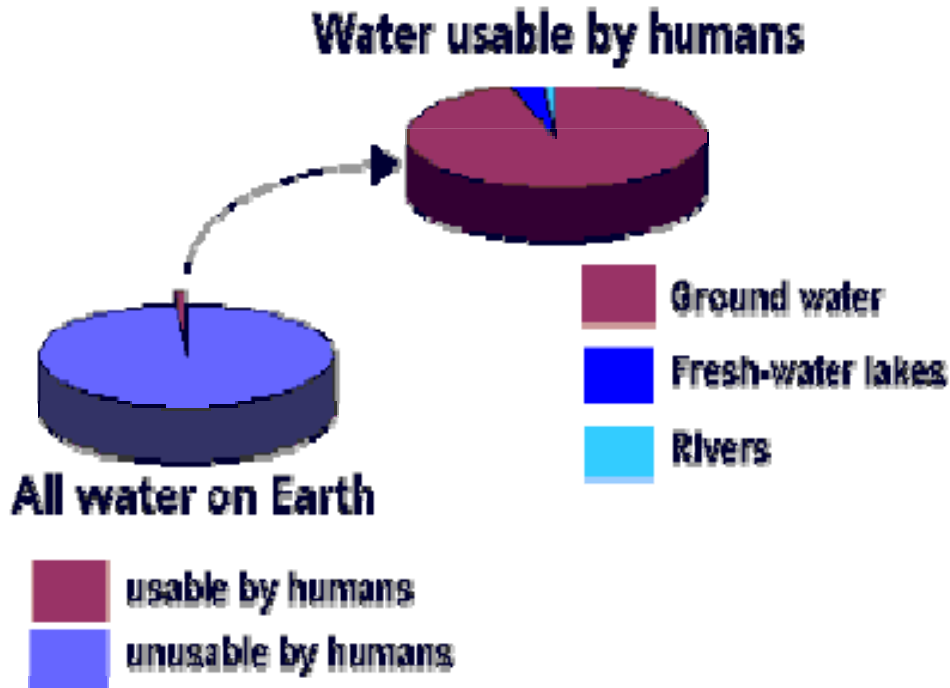


How much of Earth's water is available for our uses ... and in what forms does it exist?

You can best see how water is distributed by viewing these pie charts:

## **How much of Earth's water is usable by humans?**

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The left-side pie chart shows that over 99 percent of all water (oceans, seas, ice, most saline water, and atmospheric water) is not available for our uses. And even of the remaining fraction of one percent (the small brown slice in the top pie chart), much of that is out of reach. Considering that most of the water we use in everyday life comes from rivers (the small light blue slice in the right-side pie chart), you'll see we generally only make use of a tiny portion of the available water supplies. The right-side pie shows that the vast majority of the fresh water available for our uses is stored in the ground (the large brown slice in the second pie chart).

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• U.S. Department of the Interior | U.S. Geological Survey  
URL: <http://ga.water.usgs.gov/edu/earthwherewater.html>  
Page Contact Information: Howard Perlman

## YEAR 7

### Activity One: Water Cycle

**AIM:** To explain the water cycle by identifying the processes involved.

#### Materials

- wall chart/blackboard/markers
- plastic bag/string/rubber band

#### Time

- two class periods (discussions and experiment)

#### What to do

1. Draw the diagram of the Water Cycle in the Year 7 Science Book, page 22, on a wall chart or the blackboard.
2. Label the diagram and discuss the main processes occurring: evaporation, condensation, precipitation and collection.
3. Ask 3 students to draw three trees in the water cycle.
4. Discuss the connection between the trees and the water cycle.
5. Ask students to draw arrows to show the direction of movement of water showing this connection.
6. What is the name of this process? Discuss and explain including the terms: photosynthesis, absorption, and transpiration.
7. Arrange class into groups of fours or fives and explain the experiment to investigate transpiration in plants. (Fine day is suitable for the experiment)
8. Write the aim on the board. (You may lead the students to state a suitable aim).
9. Each group will look for a plant outside the school grounds.
10. Tie a plastic bag around one or two leaves using string or a rubber band.
11. Leave until the next day then collect your plastic bag.
12. Observe and record your results. Discuss with your group what happened, why it happened and its connection to the water cycle.
13. Write up your experiment in the standard scientific format and answer these questions.

#### Questions

- (i) What are some uses of water to plants, animals and humans?
- (ii) Is the water that existed millions of years ago still on earth? Explain your answer.
- (iii) What will happen if one of the processes involved in the water cycle does not function?
- (iv) How can you be sure that it is water inside the plastic bag?

## Activity Two: How much water?

**AIM:** To use apparatus to carry out measurements & do calculations.

### Materials

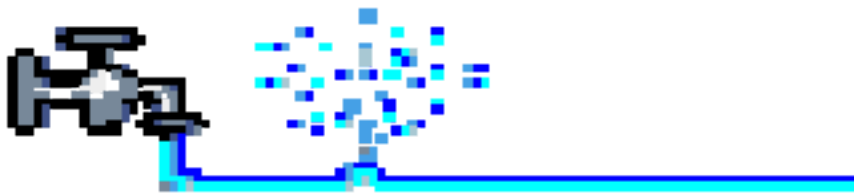
- measuring cylinders/containers/eye dropper
- 2 clear containers of the same type
- cordial/Raro/Sprim
- newsprint/markers
- protractor/compass/calculator

### Time

- two class periods

### What to do

1. Divide class into four or five groups to carry out activity.
2. Half fill a 2 litre ice-cream container with water.
3. Pour in 2 caps of cordial or some powdered drink mix like Raro or Sprim and stir.
4. Measure 1000 mls of this coloured water using a measuring cylinder. (Use whatever volumes are available in your school). Pour this into a clear container. This represents all of the earth's supply of water.
5. Pour 28 mls of this total water into another clear container of the same size. This represents the earth's total fresh water supply. How much of the earth's water is saltwater? Discuss and explain.
6. Divide the 28 mls of freshwater into small beakers or containers as follows:
  - 23 mls for icecap and glaciers;
  - 4 mls for ground water;
  - 2 drops for surface water; and
  - 1 drop for water in the atmosphere and the soil.
7. Discuss and explain frozen freshwater, ground water, surface water and water in the atmosphere and soil.
8. Calculate the percentages of earth's fresh water.
9. Use your calculations to draw a pie chart in your groups.
10. Each group to write two statements as a conclusion to present to the class.
11. Discuss findings and display work.



## Activity Three: Water Inventory

**AIM:** To collect information about water usage & wastage at home.

### Materials

- questionnaire
- measuring cylinders/calculators

### Time

- two class periods

### What to do

1. Hand out the Questionnaire to the students or write on the board for them to copy. Explain and discuss.
2. Students to take Questionnaire and return in 3 days time.

### Questionnaire

- (i) What kind of water do you drink at home? (tap/well/tank/bottled)
- (ii) What happens when your tap/well/or tank water is dirty?
- (iii) How can you tell if your well or tank water is clean?
- (iv) How many taps are in your home?
- (v) Do any of them leak? How many?
- (vi) If there is a leaking tap in your house, place a container under it to collect the dripping water for 30 minutes. After 30 minutes, then pour the water collected into a bottle with a lid or a closed container to take to school to measure.
- (vii) Is your water supply metered or do you pay a yearly amount?
- (viii) How much does your family pay for three months or for a year?
- (ix) How much water do you use at home on a typical day? Cooking a meal uses about 10 litres of water; washing dishes uses 9 litres; washing clothes by hand uses 60 litres and by washing machine up to 155 litres per cycle; flushing toilets needs 11 litres and 8-minute showers uses 120 litres.

### Finishing up in classroom

1. Measure water from leaking taps. Calculate how much water is wasted in one day and one week. Calculate the cost of water lost in one day and one week.
2. Go through the questionnaire, share responses and discuss.
3. Students to write a paragraph about water wastage and water use in their families.

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• Deo, S. & Bower, R. **The Pacific Freshwater Education Kit – Activities 21.** SPREP

## fact sheet eighteen: Ground Water & Water Stress

### Water resources

These are sources of water that are useful to humans. Uses of water include agricultural, industrial, household, recreational and environmental activities. All of these human uses require fresh water. Fresh water is a renewable resource, yet the world's supply of clean, fresh water is steadily decreasing. Water demand already exceeds supply in many parts of the world, and as world population continues to rise, many more areas are expected to experience this imbalance in the near future. The framework for allocating water resources to water users is known as water rights.

### Earth's Water: Ground water

There is an immense amount of water in aquifers below the earth's surface. In fact, there is a hundred times more water in the ground than is in all the world's rivers and lakes. Some water underlies the Earth's surface almost everywhere, beneath hills, mountains, plains, and deserts. It is not always accessible, or fresh enough for use without treatment, and it's sometimes difficult to locate or to measure and describe. Ground water is an important part of the water cycle. Ground water is the part of precipitation that seeps down through the soil until it reaches rock material that is saturated with water. Water in the ground is stored in the spaces between rock particles. Ground water slowly moves underground, generally at a downward angle (because of gravity), and may eventually seep into streams, lakes, and oceans.

### Why is there ground water?

A couple of important factors are responsible for the existence of ground water:

#### **(1) Gravity**

Gravity pulls water towards the center of the Earth. That means that water on the surface will try to seep into the ground below it.

#### **(2) The Rocks Below Our Feet**

The rock below the Earth's surface is the bedrock. Earth's bedrock consists of many types of rock, such as sandstone, granite, and limestone. Bedrocks have varying amounts of void spaces in them where ground water accumulates. Sometimes when building a road, the layers are revealed by road cuts, and water can be seen seeping out through the exposed layers.

### Water stress

The concept of water stress is relatively simple: it applies to situations where there is not enough water for all uses, whether agricultural, industrial or domestic.

- **Population growth** - In 2000, the world population was 6.2 billion. The UN estimates that by 2050 there will be an additional 3 billion people with most of the growth in developing countries that already suffer water stress. Thus, water demand will increase unless there are corresponding increases in water conservation and recycling of this vital resource.
- **Increased affluence** - The rate of poverty alleviation is increasing especially within the two population giants of China and India. Increasing affluence means more water consumption: from needing clean fresh water 24 hours a day, 7 days a week and basic sanitation service, to demanding water for gardens and car washing, to wanting private swimming pools.
- **Expansion of business activity** - Business activity ranging from industrialisation to services such as tourism and entertainment continues to expand rapidly. This expansion requires increased water services including both supply and sanitation, which can lead to more pressure on water resources and natural ecosystems.
- **Rapid urbanisation** - The trend towards urbanisation is accelerating. Small private wells and septic tanks that work well in low-density communities are not feasible within high-density urban areas. Urbanisation requires significant investment in water infrastructure in order to deliver water to individuals and to process the concentrations of wastewater – both from individuals and from business. These polluted and contaminated waters must be treated or they pose unacceptable public health risks.
- **Climate change** – This could have significant impacts on water resources around the world because of the close connections between the climate and water cycle. Rising temperatures will increase evaporation and lead to increases in precipitation, though there will be regional variations in rainfall. Overall, the global supply of freshwater will increase. Both droughts and floods may become more frequent in different regions at different times, and dramatic changes in snowfall and snowmelt are expected in mountainous areas.

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U.S. Department of the Interior | U.S. Geological Survey  
 URL: <http://ga.water.usgs.gov/edu/earthwherewater.html>

• Waller, Roger M., **Ground Water and the Rural Homeowner**, Pamphlet, U.S. Geological Survey, 1982

## YEAR 8

### Activity One: Boiling Water

**AIM:** To use science apparatus correctly to carry out an experiment.

#### Materials

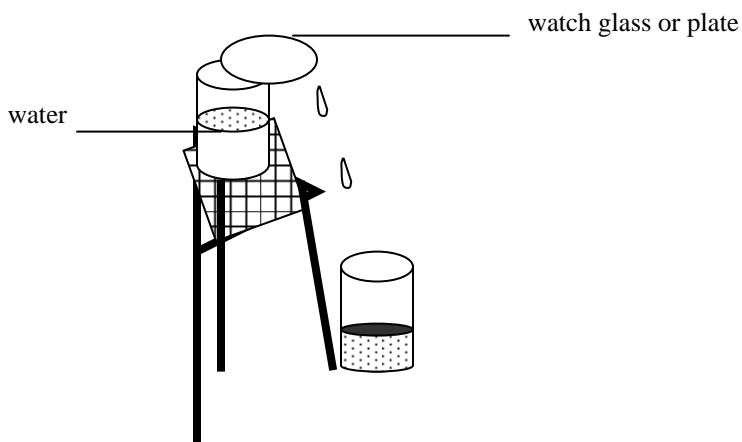
- Bunsen burner/tripod and gauze/ thermometer/beakers
- measuring cylinders/watch glass or plate/stopwatch or watch

#### Time

- one class period

#### What to do

1. Divide the class into 4 groups. Give instructions: two groups will boil 100 mLs of water and the other two will boil 200 mLs of water.
2. Measure 100 mLs or 200 mLs (depending on your group's work) of water and pour it into the beaker.
3. Record the temperature of the water.
4. Use the Bunsen burner to heat the water. Start timing as soon as you start heating.
5. Every minute, gently stir the water and note the temperature.
6. Keep taking temperature readings every minute until the water boils.
7. Write the results on the blackboard. (Use sample table below)
8. When the water boils, place a watch glass or plate on the beaker and collect droplets of water in another smaller beaker.



9. Write up the experiment in your lab book in the standard scientific format.
  - Write down a suitable aim of this experiment



- Draw a diagram of the equipment being used and briefly explain what you did.
- Draw up a result table like the one on the blackboard.

Time (minutes)							
Temperature (°C) for 100 mLs of water							
Temperature (°C) for 200 mLs of water							

10. Answer the following questions:
- (i) What was the boiling point of your water sample?
  - (ii) Which volume of water boiled first? Explain why.
  - (iii) Explain what happened in Step Number 8. How does this relate to the Water Cycle?
  - (iv) Write a conclusion for the experiment.
  - (v) Plot your results on a line graph.

## Activity Two: Television Commercial

**AIM:** To create a television commercial to promote water resources.

### Materials

- student ideas

### Time

- two class periods

### What to do

1. Write down “WATER RESOURCES” on the board.
2. Brainstorm ideas and discuss with students. Should include: uses, properties, conservation, pollution, etc.
3. Discuss some commercials about water students know from television:
  - what they were about;
  - what they think about them;
  - were they effective in relaying the message about water; and
  - how would you improve it.
4. Arrange class into 4 or 5 groups. Each group will design, develop and present a TV commercial about any aspect of water resources. (You may present the best one or all of them during a school assembly, or videotape presentations).



## Activity Three: Health & Hygiene

- Specialist from Ministry of Health to talk about health & hygiene related to water issues and waterborne diseases common in Samoa and the Pacific

**AIM: To find out about health & hygiene related to water resources.**

### **Materials**

- specialist & related materials
- newsprint/markers/glue

### **Time**

- two class periods

### **What to do**

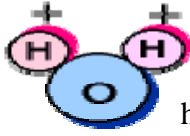
1. Divide class into 2 groups and assign their responsibilities during the specialist's presentation.  
  
Group 1 - Collect information about diseases related to water. Names, symptoms, treatment, prevention.  
Group 2 - What are good hygiene practices to prevent water related diseases?
2. After the presentation, give each group some newsprint to present the information they received from the specialist.
3. Discuss the work presented and display on the board.
4. Class to design and produce awareness posters and signs to place in various places in the school grounds. Discuss where to place them and why.

## fact sheet nineteen: Water Facts

### Water properties

What are the physical and chemical properties of water that make it so unique and necessary for living things? Pure water is colorless and has no taste or smell. But the hidden qualities of water make it a most interesting subject.

### Water's Chemical Properties



Water's chemical description is  $H_2O$ . As the diagram to the left shows, that is one atom of oxygen bound to two atoms of hydrogen. Hydrogen has a positive charge while oxygen has a negative charge. Since opposite electrical charges attract, water molecules tend to attract each other, making water kind of "sticky." The side with the hydrogen atoms (positive charge) attracts the oxygen side (negative charge) of a different water molecule. All these water molecules attracting each other mean they tend to clump together. This is why water drops are, in fact, drops! If it wasn't for some of Earth's forces, such as gravity, a drop of water would be ball shaped -- a perfect sphere.

Water is called the "universal solvent" because it dissolves more substances than any other liquid. This means that wherever water goes, either through the ground or through our bodies, it takes along valuable chemicals, minerals, and nutrients.

Pure water has a neutral pH of 7, which is neither acidic nor basic.

### Water's Physical Properties

- Water is unique in that it is the only natural substance that is found in all three states -- liquid, solid (ice), and gas (steam) -- at the temperatures normally found on Earth.
- Water freezes at  $0^{\circ}$  Celsius (C) and boils at  $100^{\circ}$  C. Water is unusual in that the solid form, ice, is less dense than the liquid form, which is why ice floats.
- Water has a high specific heat index. This means that water can absorb a lot of heat before it begins to get hot. This is why water is valuable to industries and in your car's radiator as a coolant.
- Water has a very high surface tension. In other words, water is sticky and elastic, and tends to clump together in drops rather than spread out in a thin film. Surface tension is responsible for capillary action, which allows water (and its dissolved substances) to move through the roots of plants and through the tiny blood vessels in our bodies.

## What is a watershed?

A watershed is the area of land where all of the water that falls in it and drains off of it goes into the same place. Watersheds can be as small as a footprint or large enough to encompass all the land that drains water into rivers where it enters the ocean. The word watershed is sometimes used interchangeably with drainage basin or catchment. A watershed is a precipitation collector. Not all precipitation that falls in a watershed flows out.

Aquifer A formation, group of formations, or part of a formation that contains sufficient saturated, permeable material to yield significant quantities of water to wells and springs.

## Desalination

Is an artificial process by which saline water (generally sea water) is converted to fresh water. The most common desalination processes are distillation and reverse osmosis. Desalination is currently expensive compared to most alternative sources of water, and only a very small fraction of total human use is satisfied by desalination. It is only economically practical for high-valued uses (such as household and industrial uses) in arid areas. The most extensive use is in the Persian Gulf.

## Frozen water

Several schemes have been proposed to make use of icebergs as a water source, however to date this has only been done for novelty purposes. Glacier runoff is considered to be surface water.

## Water Quality

Water quality is a term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. Although scientific measurements are used to define water's quality, it's not a simple thing to say that "this water is good," or "this water is bad." When the average person asks about water quality, they probably want to know if the water is good enough to use at home, to play in, to serve in a restaurant, etc., or if the quality of our natural waters is suitable for aquatic plants and animals. Assessment of the occurrence of chemicals that can harm water quality, such as nutrients and pesticides in water resources, requires recognition of complicated interconnections among surface water and ground water, atmospheric contributions, natural landscape features, human activities, and aquatic health. •

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• [U.S. Department of the Interior | U.S. Geological Survey](#)  
URL: <http://ga.water.usgs.gov/edu/earthwherewater.html> • Waller, Roger M., **Ground Water and the urban Home**

## YEAR 9

### Activity One: Separating Mixtures

**AIM:** To carry out a research about methods used in water treatment.

#### Materials

- information from various sources: Internet; magazines, books, newspapers, MNRE, SPREP, Samoa Water Authority, Bottled water companies, etc.

#### Time

- depends on information available. If students collect their own, then one week may be needed for this on their own time. Class time might be only 2 class periods: discussing topic and presentations.

#### What to do

1. Divide class into 3 groups and each group will be given a topic for a research project.
2. Groups will gather and collect information on how one of the following uses the **separating of a mixture** to improve our quality of life:
  - (i) water treatment;
  - (ii) sewage treatment; and
  - (iii) making fresh water by desalinization of seawater.
3. Use the information collected to construct a wall chart with a large diagram to illustrate their given topic.
4. Groups will present their findings to the rest of the class.

## Activity Two: Water Ways

**AIM:** To see & find out how water supply reaches the home & school.

- Visit to the Samoa Water Authority or Specialist presentation

### Materials

- Samoa Water Authority specialists

### Time

- two class periods

### What to do

1. Arrange a visit to the Samoa Water Authority to show students how water is collected and piped to get to school and to their homes. Ask specialists at the Authority to also talk about water treatment, metering and conservation. If this is not possible, invite the specialists for a presentation.
2. Students will participate in the visit and take notes, ask questions and write a full report about the visit.
3. In the classroom, discuss information gathered and prepare a Questionnaire for students to answer. The one given below is a guide and you may add or subtract to it.
4. Summarise student responses to the questionnaire by writing on the board or newsprint. Students to write their responses in a table and discussions should follow of the different issues raised. These should be related to the specialist talk and visit.
5. Discuss how human activities may affect the work of the Samoa Water Authority.

### Questionnaire

- (i) How many taps do you have at home?
- (ii) Do any of them leak? How many?
- (iii) What can you do to stop your taps leaking?
- (iv) What kind of toilet do you have in your home?
- (v) How is the waste collected or stored? Septic tanks or hole in the ground?
- (vi) Are there leakages in these waste collectors?
- (vii) What should be done and why?
- (viii) Do you have a pig sty at your home or if not do your neighbours have one?
- (ix) What happens to the pigs waste? What happens when it rains?
- (x) Who do you contact when you have problems with smell from leaking tanks and smelly pig sties?
- (xi) Name some other human activities that may affect our water ways.

## Activity Three: Water News

**AIM:** To produce a water newsletter or newspaper to promote awareness of water resources in the school.

### Materials

- newsprint/ A4 paper/markers

### Time

- three class periods

### What to do

1. Tell the class that they will do a class project producing a newsletter or newspaper to inform the school or community about water.
2. Class will then select the editor, researchers, writers, layout designers, illustrators, production teams, etc. Teacher should guide students to what is needed.
3. Students to discuss and plan their newsletter and start to collect and produce their items.
4. Some information that might be of interest may include the following:
  - (i) Facts about water;
  - (ii) Uses of water;
  - (iii) Sources of water in Samoa;
  - (iv) Water – a renewable resource becoming limited;
  - (v) Water pollution in Samoa;
  - (vi) Water conservation in Samoa;
  - (vii) Effects of human activities on water resources;
  - (viii) Ways in which we may help to conserve water.



## fact sheet twenty: Watershed Management in Samoa

### Watershed Management in Samoa

All of Samoa's forty river systems originate in the mountainous areas and drain into the sea creating watersheds defined as **"a region draining into a river, river system or other body of water"**. The rivers are fairly evenly distributed throughout Samoa with the exception of Savaii where the land is considered to be dry. The rivers are partly perennial and partly seasonal in character. These rivers are Samoa's main source of fresh water, comprising 75% of Samoa's water sources. Other sources of water include springs at 15%, boreholes 5% and rainwater 5%. The pattern of flow and the quality of water from these sources depend on the condition of the watershed.

Water in the watersheds is being used for drinking, domestic and industrial uses and hydropower. In 1981, 80% of the country's electric power was generated by diesel plants, whereas today, close to 80% of the electric power is generated by hydropower. An evaluation of watersheds in 1983 identified five major watersheds in Samoa: the Vaisigano River (Upolu), Fuluasou River (Upolu), Faleaseela River (Upolu) and Vailoa-Faleata Rivers (Savaii). Close to 58% of these areas were in natural condition (undisturbed), 34% were disturbed and 7% were disturbed and in extremely degraded conditions. After the two cyclones Ofa and Val in 1990 and 1991, the condition of these watersheds changed drastically. For instance, a Forestry Division assessment of cyclone damage in the Vaisigano watershed indicated a 40% level of uprooted trees and 50% of badly damaged standing trees.

The watershed condition inventory carried out in 1983 has clearly indicated the status, problems and the immediate actions needed for highly degraded watershed areas in Samoa. However, the constant forest clearance of lands by villagers, the opening of new village roads and other development activities has contributed to the deterioration of the country's watersheds. The protection of mountain watersheds has a direct or indirect impact on soil fertility, which essentially influences agricultural developments. The degradation of watersheds has a direct impact on water quantity and quality. Low quality water is unacceptable for human and livestock consumption, at the same time a reduction in quantity has a severe effect on water consumption, hydropower generation, irrigation and industrial uses.

Furthermore, the siltation of hydropower and the water supply scheme constitute a major problem mainly in the Vaisigano and Fuluasou Rivers. The siltation of the Moamoa water intake and the contamination of water by a livestock farm upstream forced the intake to close. The Fuluasou river hydropower reservoir built in the early 1950s is completely silted up. Weedicides used upstream in the cultivated area are another major source of pollution that deteriorates the water quality and makes it unpalatable and transported via river flows to the coasts further pollutes lagoons and reefs.

### Status of Watershed Management in Samoa

Previously, government efforts to improve the management of watershed was confined to the five watersheds identified and in need of serious management in 1983. After the two cyclones in 1990 and 1991, rehabilitation of the first two watersheds was carried out by the Watershed Management Section (WMS) under the Forestry Division (FD) of the

Ministry of Agriculture, Forests, Fisheries and Meteorology. Community planting is ongoing in these identified watersheds. The individual farmers who lived in watershed areas were encouraged to incorporate planting of forest trees with their cash crops for the protection of soil and water. For other watersheds, the maintenance of these woodlots are the responsibilities of the farmers. The watershed management staff can only supply free seedlings and provide technical support.

The Government of Samoa then approved the transfer of the WMS under the Department of Lands, Surveys and Environment now being renamed MNRE, With that, an external funded project piloting effective community-based watershed management approaches at the island of Apolima and the village of Lepa. These various watershed management developments will provide some lessons and models for promoting nationwide effective community-based management of the country's watershed areas, which are largely in lands under customary land ownership or owned by village landowners.

Recently with the prioritisation of Water Resource Management, the Government of Samoa has adopted a sector wide approach known as the Water Sector Support Programme (WASSP) jointly funded by the European Union (EU) and the Government of Samoa. This sector wide approach supports the Government's national vision of: "**For every Samoan to achieve a better quality of life**" through the implementation of a common sector goal of "**Ensuring community access to water of sustainable quality and appropriate quantities to meet all reasonable health, environmental and economic development needs**".

The Water Resources Division (WRD) of the MNRE is one of the key sectors and works closely with the Ministry of Finance for the management and implementation of the project. The main activities undertaken within the project include Sustainable Water Resources Management. One of the highlight of these activities is the prioritisation of national watershed areas under "**Improved conservation and protection of water catchment areas and water resources**". Eight sites have been prioritized with 7 in Upolu and 1 in Savaii: Letogo, Vailele, Laulii, Vaisigano, Fuluasou, Faleseela, Piu, Tafitoala and Palauli.

The Watershed section is currently monitoring works implemented in the villages of Letogo and Vailele, Laulii and Vaisigano upper catchment. In March 2008, the watershed section started consultations for Faleseela. The end result will be the establishment of a village based nursery, rehabilitation works to improve the watershed area as well as the review of the watershed management plan. Of equal importance is to build the capacity of the village on the importance of watershed areas and ways to protect and conserve in a sustainable manner for the future generations of Samoa.

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• Water Resource Division of the MNRE



## YEAR 10

### Activity One: Samoan Water Stories

**AIM:** To find out about water resources & their importance in the Samoan way of life.

#### Materials

- group work

#### Time

- two class periods for introduction and presentation (groups may need a week to collect information in their own time)

#### What to do

1. Divide class into 4 groups to work on collecting information to present to class.
2. Find out information about a Samoan legend involving a river (for example: Vaisafee/Vaisigano/Vai o Sina) or the origins of a Samoan village (for example: Vaiusu/Vaimauga/Vailoa/Vaiaata). This information may be available by asking parents and village elders, visits to some of the rivers and villages if nearby to school. Groups will have to decide on their method of collecting information.
  - what is the legend about?
  - what is the origin of the village name?
  - is the water resource protected or conserved by the village?
  - is the water resource still there/still the same/changed/disappeared?
  - what is the significance of the water resource in Samoan culture or history?
  - what purposes does the water resource serve in the present community?
  - what are the effects of human activities on the water resource?
  - how can the resource be protected to last for the next generation?
3. Present information to the class in whatever format student comes up with – poster, pamphlet, song, dance, etc.
4. Discuss and display class findings.

## Activity Two: pH Levels

**AIM:** To find out using scientific apparatus about some properties of water.

### Materials

- litmus paper/ universal indicator/pH meter
- solutions: hydrochloric acid, sodium hydroxide, vinegar, milk, tap water, sea water, bottled water, limewater
- test tubes, droppers, beakers

### Time

- one class period

### What to do

1. Revise pH, indicators and properties of water.
2. Discuss and explain responses.
3. Have various solutions prepared and ready in small beakers.
  - dilute hydrochloric acid
  - sodium hydroxide
  - vinegar
  - milk
  - tap water
  - sea water
  - different types of bottled water sold in Samoa
  - limewater
4. Teacher to demonstrate experiment and students to record results for experiment write-up.
5. Add universal indicator or litmus paper to solutions and observe results.
6. Discuss results and students to write up lab in standard scientific format and hand in work.

### Results

Solution	Indicator colour	pH number	Acid or base

### Questions

1. Which is more acidic, a pH of 3 or pH 6?
2. Would a pH of 2 be suitable for a shampoo? Explain.
3. Write down two uses of pH numbers in the community.
4. Is drinking water acidic or basic? Explain.
5. Comment about the pH of the different sources of drinking water you tested. Which one would you recommend for your family to drink? Explain.
6. Find out what activities affect the pH of water and how it can be prevented or corrected.

Representative pH values	
Substance	PH
<a href="#">Hydrochloric acid, 10M</a>	-1.0
<a href="#">Lead-acid battery</a>	0.5
<a href="#">Gastric acid</a>	1.5 – 2.0
<a href="#">Lemon juice</a>	2.4
<a href="#">Cola</a>	2.5
<a href="#">Vinegar</a>	2.9
<a href="#">Orange</a> or <a href="#">apple</a> juice	3.5
<a href="#">Tomato Juice</a>	4.0
<a href="#">Beer</a>	4.5
<a href="#">Acid Rain</a>	<5.0
<a href="#">Coffee</a>	5.0
<a href="#">Tea</a> or healthy <a href="#">skin</a>	5.5
<a href="#">Urine</a>	6.0
<a href="#">Milk</a>	6.5
<a href="#">Pure Water</a>	7.0
Healthy <a href="#">human saliva</a>	6.5 – 7.4
<a href="#">Blood</a>	7.34 – 7.45
<a href="#">Seawater</a>	7.7 – 8.3
<a href="#">Hand soap</a>	9.0 – 10.0
<a href="#">Household ammonia</a>	11.5
<a href="#">Bleach</a>	12.5
<a href="#">Household lye</a>	13.5

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• Retrieved from "[http://en.wikipedia.org/wiki/pH scale](http://en.wikipedia.org/wiki/pH_scale)"

## Activity Three: Water Mural

**AIM:** To promote awareness of the importance of water resources.

- A *mural* is an artwork painted on a permanent surface such as a wall/fence/rainwater tank/etc. They are painted in a prominent position where the public can view them. They can be made by a group of people who work together to make the artwork as a team. Murals are big and colourful!

### Materials

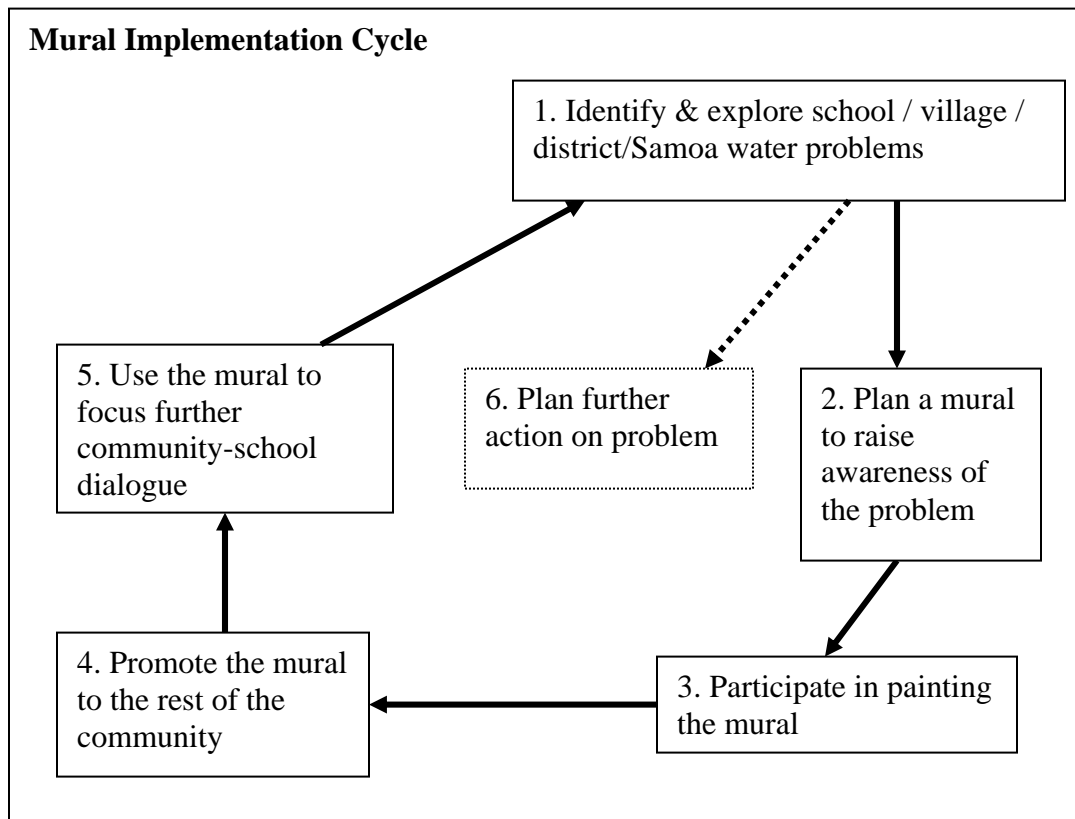
- paint/water colours/brushes

### Time

- one class period for planning and discussion then depends on how long it takes to complete mural

### What to do

1. Plan and discuss mural using guideline below.



Some ideas include the following:

- water conservation
  - water for life
  - save the blue planet
  - use water wisely
  - water cycle
  - stop water pollution
  - water storage, water quality
  - etc
2. When mural is complete, principal and school committee may be involved to invite the village and community for a ceremony to present the class mural.

Mural – Noah’s Ark • Retrieved from "<http://en.wikipedia.org/wiki/Murals>"



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• Live & Learn Environmental Education. **HOPE Teachers’ Guide**. 2006



**IX. TOPICS GUIDE CHART**  
**CLIMATE CHANGE**

Yr	Objectives	Learning Outcomes	Activity description	Curriculum connection	Skills
7	To use scientific apparatus correctly to make accurate measurements & carry out simple calculations using scientific formulae.	<ul style="list-style-type: none"> <li>- define matter, density, particles &amp; volume</li> <li>- describe the 3 states of matter</li> <li>- state the formulae for calculating volume &amp; density &amp; apply them</li> <li>- measure volume &amp; mass using proper equipment</li> <li>- state the correct units for the measurements</li> <li>- rank materials in terms of density</li> </ul>	Experiment about density.	Science – experiment on density Maths – calculations, measurements, units. Year 7 Science Book, Units 6 & 14, pgs 15 – 17; 38 – 39. <b>Assessment:</b> Measurements, calculations, write up of experiment.	Following instructions, measuring, using apparatus, calculating, reporting, stating conclusions.
7	To enable students to see sea level rise & the threats to the environment & people should it occur. To promote awareness about how to act during a natural disaster.	<ul style="list-style-type: none"> <li>- see changes during different tides</li> <li>- measure depth &amp; distance</li> <li>- answer task sheet</li> <li>- write a letter &amp; work in groups</li> <li>- name other natural disasters / hazards that may cause sea level rise</li> <li>- state what to do when tsunamis or cyclones occur</li> <li>- explain the causes of tsunamis &amp; cyclones</li> </ul>	Visit to the sea at low & high tides. Task sheet is provided for students' responses.	Science / Social Science – tides, pollution. <b>Assessment:</b> Completing task sheet, discussion.	Measuring, observation, group work, leadership, making judgements, communication writing.
7	To write sentences using words in the correct context about climate change & global warming.	<ul style="list-style-type: none"> <li>- improve vocabulary</li> <li>- use words in sentences to show understanding of concepts</li> </ul>	Word find & sentence writing relating to climate change & global warming.	English / Science / Social Science – vocabulary, sentence writing, greenhouse effect. <b>Assessment:</b> Completed word find & sentences.	Observation, vocabulary, writing, communication knowledge.

Yr	Objectives	Learning Outcomes	Activity description	Curriculum connection	Skills
8	To carry out an experiment & practice laboratory skills.	<ul style="list-style-type: none"> <li>- follow instructions</li> <li>- draw diagrams</li> <li>- apply knowledge to experiment</li> <li>- write up the lab in the correct format</li> </ul>	Experiment with sea & fresh water to observe how they interact with each other.	Science – fresh & seawater. <b>Assessment:</b> Experiment write up & answers to questions.	Observations, reporting, following instructions, using apparatus correctly, vocabulary.
8	To make equipment using simple materials & use them to make weather measurements	<ul style="list-style-type: none"> <li>- define weather</li> <li>- make measurements &amp; record them</li> <li>- know the correct units</li> <li>- measure temperature, rainfall, clouds, wind</li> <li>- make instruments &amp; use them</li> <li>- name &amp; identify cloud types</li> </ul>	Collecting information about the weather by monitoring & measuring some weather details.	Science – weather watch. Year 8 Science Book, Unit 10, pgs 28 – 30. <b>Assessment:</b> Measurements & weather report.	Use apparatus, measuring, recording, leadership, follow instructions, communicating monitoring.
8	To predict what can happen if climate change continues at its present rate.	<ul style="list-style-type: none"> <li>- describe climate change; its causes &amp; effects</li> <li>- illustrate by a skit an effect of climate change on an aspect of life in Samoa</li> <li>- work in a group</li> </ul>	Developing a skit about climate change & its effects on life in Samoa.	English – drama Social Science – life on islands & rising sea levels Science – effect of sea level rise. <b>Assessment:</b> Skits produced & discussions.	Creativity, leadership, acting, knowledge, application, oral, language, vocabulary, communication
9	To introduce the Carbon Cycle promoting awareness about deforestation, renewable energy sources & greenhouse gases & their effects.	<ul style="list-style-type: none"> <li>- draw &amp; explain the carbon cycle</li> <li>- explain the effects of deforestation, combustion of fossil fuels on the amount of carbon dioxide in the air</li> <li>- name alternative sources of energy</li> <li>- name examples of fossil fuels</li> <li>- describe how sustainable agriculture, land management &amp; forestry can reduce global warming</li> <li>- describe what a greenhouse sink is</li> </ul>	Carbon cycle & its link to the Greenhouse Effect, looking at sources of energy.	Science – global warming. Social Science – resources Year 9 Social Studies Book 1, Units 1 & 3, pgs 5 – 26, 35 – 56. Year 9 Science Book 3, Unit 4, pgs 48 – 65. <b>Assessment:</b> Answering questions for group presentations, paragraph writing.	Knowledge, application, research, computer, communication values, oral, vocabulary.

Yr	Objectives	Learning Outcomes	Activity description	Curriculum connection	Skills
9	To find out about living on an atoll & compare to Samoa. To create atolls & to visualise the threats of climate change.	<ul style="list-style-type: none"> <li>- describe what an atoll is &amp; name some in the Pacific</li> <li>- listen to speaker, make summary notes &amp; ask questions</li> <li>- create own atoll applying their knowledge</li> <li>- describe the effects of climate change on atoll life</li> </ul>	Guest speaker from an atoll island & students will then design their own atolls.	Science / Social Science – life on an atoll, effect of sea level rise English – case study <b>Assessment:</b> Imaginary atolls, discussions.	Creativity, listening, oral, application, designing, work in groups, leadership, values, drawing, planning, organising, communication
9	To use scientific apparatus to carry out experiments to illustrate concepts studied.	<ul style="list-style-type: none"> <li>- follow instructions</li> <li>- observe, record results, analyse results</li> <li>- answer questions</li> <li>- make decisions, formulate conclusions &amp; provide evidence for support</li> </ul>	Experiments on Oceans Rising, looking at effect of heat on water & melting ice cubes on sea level.	Science – experiments <b>Assessment:</b> Write up of experiment, answering questions, discussions & presentations of findings.	Using apparatus, observation, application, knowledge, writing, communication
10	To use scientific equipment correctly, follow instructions & write up experiment.	<ul style="list-style-type: none"> <li>- measure temperature &amp; time</li> <li>- use correct units</li> <li>- apply knowledge to explain results</li> <li>- tabulate results</li> <li>-write up experiment</li> </ul>	Experiment on heat transfer & questions for students to answer & apply knowledge.	Science – experiment. <b>Assessment:</b> Experiment write up & answering questions.	Measurements, vocabulary, work in groups, observation, writing, application, communication
10	To use photographs to provide ideas about climate change & its effects on weather patterns leading to natural disasters.	<ul style="list-style-type: none"> <li>- define urbanisation</li> <li>- describe effects of urbanisation on climate change</li> <li>-describe health problems related to flooding</li> <li>- describe effects of climate change on Samoan environment</li> </ul>	Viewing photographs & using them to answer questions.	English – essay writing, Science / Social Science – urbanisation. Year 10 Science Book 3, Unit 2, pgs 18 – 31. <b>Assessment:</b> Essay.	Observation, application, knowledge, creativity, cooperation, writing, vocabulary.
10	To find information & apply knowledge about climate change & its	<ul style="list-style-type: none"> <li>- define ecosystem &amp; name some examples</li> <li>- describe interdependencies within an ecosystem</li> <li>- gather, select &amp;</li> </ul>	Research on the effects of climate change on an ecosystem, how it will	Science – ecosystem study <b>Assessment:</b> Answering questions & presenting information to	Research, computer, group work, leadership, organisation, oral,

	effects on various ecosystems in Samoa	process information from various sources - write project & present to class	affect the organisms that depend on each other.	class about the various ecosystems.	communication Presentation, vocabulary.
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## fact sheet twenty one: Climate Change

### CLIMATE CHANGE

The term “climate” refers to the long-term pattern of weather, which is observed at a particular area. Although climate changes frequently, the annual pattern of weather in a specific location is relatively constant over time. The global climate system is a complex and interactive network of natural physical processes, which are influenced by the interactions of solar energy, the Earth’s surface and the atmosphere.

#### The Greenhouse Effect

Not all of the sun’s energy reaches the earth. About 30% is reflected back into space while the rest is either transferred around the globe by winds and ocean currents or trapped by gases in the atmosphere.

The atmosphere that surrounds our planet acts like a protective blanket, keeping the earth warm. As the earth rotates and is heated, the air moves as winds and mixes with ocean currents. This determines the climate and keeps the earth from getting too hot. The oceans store a lot of the sun’s energy and transport this heat through currents circulating around the planet. The sun warms the seas and oceans which make currents of water where hot water rises and pushes cold water down. This warm and cold mixing creates the currents bringing food from the bottom to feed marine life. Oceans cover 70 percent of the earth and help keep the earth from getting too hot.

The ability of some gases to trap heat works the same way as glass in a greenhouse, which is why this phenomenon is known as the Greenhouse Effect. It keeps the average surface temperature on Earth in a range needed to sustain life – without it, the Earth would be about 30<sup>o</sup> C cooler. The main greenhouse gases are:

- **Water vapour**
- **Carbon dioxide CO<sub>2</sub>** - released by all living things during respiration. Also produced by burning fuels such as wood, charcoal, diesel and petrol. Human activities have greatly increased the amount of this gas in the atmosphere during the past 40 years.
- **Methane CH<sub>4</sub>** – Animals like cows and goats produce methane when they digest their food and burp. Rotting organic rubbish in dumps, producing and transporting coal, oil and natural gas also produces a lot of methane.
- **Nitrous oxide N<sub>2</sub>O** – Naturally produced by oceans and lightning. It is found in manure and chemical fertilizers used in agriculture.

In order to sustain life as we know it is important that the earth’s incoming and outgoing energy is maintained in balance. Due to rapid increase in human activities such as the burning of fossil fuels, greenhouse gas emissions have become much higher than natural

levels. This in turn will disturb the earth's energy balance resulting in global warming and climate change.

Even though greenhouse gas emissions from Samoa are relatively small, that does not mean that it is exempt from the impacts of climate change. Samoa is among those countries most vulnerable to climate change, which is why it is important that the issue is understood so that precautions can be taken to protect our future.

### Impacts of climate change

Climate change has the ability to adversely affect society and the environment. The effects and impacts are most acutely felt in small island states such as Samoa.

- Sea level rise due to the thermal expansion of the upper layers of ocean is expected to place great stress on coastal ecosystems. Shorelines will undergo erosion; coastal areas will be more prone to flooding that can affect habitation, water supply, agriculture, forestry and suitable energy.
- Extreme weather events such as cyclones, wind damage, storm waves, heavy rains and flooding are likely to increase in frequency and intensity with climate change.
- Industry and human settlement concentrated along the coast, especially in areas where the sea is a major source of income through fishing, tourism and transport, will be most vulnerable to sea level rise as a result of climate change.
- Human health will be affected. Higher temperatures may lead to a higher incidence of heart and respiratory diseases. There will be a rise in mortality due to heat stress. Warmer conditions can also increase the population of disease carrying organisms such as mosquitoes, and hence cause a rise in vector and water borne diseases.
- Agriculture will be affected due to changes in rainfall patterns. Crop yields, productivity, proliferation of plant pests and insects from warmer and wetter conditions.
- Tourism industry important to many small island states will be affected as well. Change in climate may lead to: the loss of beach due to erosion and inundation; salt water intrusion affecting freshwater supplies; increased strain on coastal ecosystems; and damage to infrastructure from tropical storms.
- Loss of habitat can affect plant and animal life and damage the overall biodiversity of Samoa.

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• Spiller, G. & A. Mejia-restrepo. **Climate change and marine conservation**. 2003 MESC-CMAD  
•MNRE. **Education Resource Kit notes**.

## YEAR 7

### Activity One: Density

**AIM:** To calculate volume & density.

#### Materials

- blocks of wood (cubes), blocks of plastic, blocks of metals
- books, scales/balances, rulers

#### Time

- 2 class periods

#### What to do

1. Write the term MATTER on the board and discuss with students to see what they think it means.
2. Revise matter – states of matter, change of state, particles of matter, etc.
3. Write the term DENSITY on the board and ask students what they know about the term coming to a definition of density.
4. Write the formula for calculating density on the board:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

5. Ask the class: How do we find the mass of an object? Discuss and explain.
6. Ask the class: How do we find the volume of an object? Discuss and explain using the formula:

$$\text{Volume} = \text{length} \times \text{width} \times \text{height}$$

7. Get your blocks/cubes of wood, of plastic, of metal and a book/s. Ask the class to rank the objects in what they think is the densest to the least dense. Discuss and explain. Write your ranking on the board or newsprint. Ask how they can find out for sure.
8. Divide the class into 5 groups or depending on the number of objects you have, and give each an object to calculate the density.
9. Each group will then use rulers to measure the length, width and height of their object to the nearest centimeter.
10. Use these measurements to calculate the volume of the object. What is the unit for volume? Discuss and explain.
11. Each group will weigh their objects using scales or balances to the nearest gram.
12. Calculate the density of each object using the formula and write your results on the board or newsprint.

13. Rank your objects in order of the densest to the least dense and compare with your original ranking.
14. The density of fresh water is very close to  $1\text{g/cm}^3$ . Which of your objects will sink and which ones will float? Why?
15. Write up the activity in your book with a conclusion about what you have learnt.

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• SEREAD and ARGO. **Oceans Rising.**



## Activity Two: Sea Level

**AIM:** To observe & measure sea level promoting awareness about natural disasters.

- Visit to the sea at low and high tide

### Materials

- metre rulers
- newsprint/markers

### Time

- two class periods

### What to do

1. Divide the class into 4 groups and take them to the beach at low tide and high tide. Give out the following task sheet for them to complete.
2. At the beach, allocate the groups to different areas about 5 metres apart.

### Task Sheet

#### Low Tide:

- (i) Measure the distance from the beach to where the seawater is.
- (ii) Measure the depth of the water at this area.
- (iii) Look for signs of pollution on the beach. Write down the sources of pollution.
- (iv) Are there any houses near the beach? Explain.
- (v) Do the people remove the sand at this beach?

#### High Tide:

- (i) Where is the water now compared to low tide?
- (ii) Measure the depth of the water at the high tide level.
- (iii) Does this beach need a sea wall? Explain.  
If there is a sea wall already in place, explain why it was built.
- (iv) Ask elders of your family or village if the sea level was like this when they were young.
- (v) What could have happened to cause this change?
- (vi) What will happen if the sea level continues to rise?
- (vii) If a sea wall is needed to be built in your study area, write a letter to the Government to request one. You should include the effects on your village if the sea wall is not built.  
If a sea wall is already in place, your class should think of ways to inform your village of what to do to maintain this sea wall.

In the classroom:

3. Prepare newsprint or brown paper for the groups to fill in their findings according to the task sheet.
4. Discuss the responses and ask the class to name other natural activities that may cause the sea level to rise. Students should mention cyclones, storms, tsunamis.
5. Discuss these natural hazards, their causes and how to prepare & behave should one occur.
6. Discuss these with the students: What did your school do on the day that Samoa had the Tsunami drill? Name a cyclone that occurred in Samoa in the past ten years

## Activity Three: Word Find

**AIM:** To use words correctly in a sentence.

**Materials**

- copies of word maze

**Time**

- one class period

**What to do**

1. Find the following words in the grid below by circling the letters. They may be up, down, backwards or diagonal.
2. Use each word in a sentence about climate change and global warming.

**Word List:**

greenhouse	weather	climate
atmosphere	cyclones	carbon dioxide
methane	temperature	rainfall
floods	changes	humidity
global	erosion	gases
sea level	pollution	corals

G	A	S	E	S	B	L	E	V	E	L	A	E	S
R	R	E	H	T	A	E	W	P	A	T	T	E	R
E	T	E	C	L	I	M	A	T	E	T	R	I	A
A	E	K	E	S	G	L	O	B	A	L	A	W	N
T	M	C	S	N	D	S	E	T	R	N	I	Y	O
S	P	Y	E	S	H	D	M	E	E	T	N	T	I
M	E	C	G	O	T	O	M	E	R	O	F	I	T
E	R	L	N	U	S	O	U	R	I	N	A	D	U
T	A	O	A	P	T	L	A	S	T	E	L	I	L
H	T	N	H	S	O	F	O	R	E	R	L	M	L
A	U	E	C	C	O	R	A	L	S	O	A	U	O
N	R	S	A	D	E	R	A	I	N	T	I	H	P
E	E	D	I	X	O	I	D	N	O	B	R	A	C

## fact sheet twenty two: Global Warming

### **Global warming**

Global warming from increasing levels of greenhouse gasses is expected to have serious effects on the Pacific Ocean. Most marine organisms live within narrow temperature regimes, and even short-term extreme temperature increase can have a dramatic impact. In the past two decades, for example, short-term extreme high temperatures contributed to a decline of coral reefs throughout the tropics. Corals, stressed by high temperatures, may eject their symbiotic algae. Coral bleaching, as this is called, renders the corals less able to cope with additional physiological stress and many of the colonies die. Some scientists expressed the opinion that it was now too late to save the coral reefs of the planet even if greenhouse gas emissions could begin to drop immediately.

This has significant impacts on organisms, such as fish, that depend on the living coral structures. In 1994, elevated sea temperatures killed over 90% of the living corals of American Samoa from the intertidal zone to a depth of 10 meters and fishing catches declined drastically in the wake of the coral death.

Temperature also regulates the distribution of plants and animals. Pelagic fish commonly migrate along temperature boundaries and, in some cases; this can result in fish moving away from traditional fishing areas. Samoa, for example, is on the edge of major tuna migrations and fishing success can oscillate from extreme success to failure depending on ocean temperature regimes.

### **Sea Level Rise**

In most Pacific islands, the people, agricultural land, tourist resorts and infrastructure (including roads and airports) are concentrated in the coastal zones, and are thus especially vulnerable to any rise in sea level.

Global warming is causing a rise in sea level from thermal expansion as the sea warms up and from melting of the planet's ice caps. Data compiled from 11 tide gauges by Australia's National Tidal Facility at Flinders University show considerable variability. For example, in September of 1997, the tide gauge in Samoa had been operating for 56 months and showed an average sea level rise of +19.2 mm per year. But the following year, when recalculated over 68 months of operation, the average sea level rise turned out to be falling at -19.5 mm per year. In Fiji, the calculated sea level rise over 61 months of operation was +21.5 mm a year in 1997, but after 73 months was recalculated as +5.2 mm a year. The conclusion is that changes in sea level are related to a multitude of variables and no realistic trend can be detected from the data for many years to come.

### **Costs of climate change**

Sea level rise will have negative impacts on tourism, freshwater availability and quality, aquaculture, agriculture, human settlements, financial services and human health. Storm surges are likely to have a harmful impact on low-lying islands.

Low lying coastal areas of all islands are especially vulnerable to a rising sea level, as well as to changes in rainfall, storm frequency and intensity. Inundation, flooding, erosion and intrusion of seawater are among the likely impacts. These catastrophes would result in economic and social costs beyond the capacity of most Pacific island countries

and threaten the very existence of small atoll countries. Shifts in rainfall regimes and any increase in tropical cyclone intensity and frequency greatly amplify the impact of sea level rise. A rise of average sea level by one metre could easily submerge low-lying islands.

The costs of responding to climate change depend on the options considered. They include (i) prevention: striving to prevent climate change; (ii) adaptation: emphasising strategies and measures for reducing expected damages; and (iii) policies: indirectly inducing reduced emissions of greenhouse gases. Although accurate estimates of costs of protection against climate change have not been finalised in Pacific islands, adaptations to climate change could cost billions of dollars. Pacific islanders are not impressed with these estimates, pointing out that for many islands, their entire culture and perhaps their lives are at risk.

### **Responding to climate change**

The small island developing states of the world banded together into an Alliance of Small Island States (AOSIS) during the 1990 Second World Climate Conference in Geneva. This united front played a central role in shaping international policy on climate change and is a classic example of cooperation for environmental reform. With considerable justification, AOSIS claims that metropolitan countries will need to pay damages to their countries and must begin meaningful reductions of greenhouse gasses without further delay. Tuvalu points out that the damages might be very expensive, as their islands may well become uninhabitable because of sea level rise.

Since 1980, considerable effort has been made to:

- (i) raise awareness of climate change;
- (ii) monitor research developments;
- (iii) develop methodologies for vulnerability assessment;
- (iv) monitor sea level rise; and
- (v) strengthen national capacity to understand the science, impacts and responses to climate change and sea level rise.

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••• EXTRACT FROM 1998 COMMUNIQUÉ. 1999 Forum Communiqué Thirtieth South Pacific Forum Koror, Republic of Palau 3 - 5 October 1999  
<http://chacmool.sdn.org/pacific/forumsec/docs/fc99.htm>

## YEAR 8

### Activity One: Fresh & Sea Water

**AIM:** To carry out experiment about fresh & sea water.

#### Materials

- 2 x 250 mls beakers/ 2 smaller beakers or containers
- 2 eyedroppers/salt/food colouring (2 different colours)
- tablespoon/marker pen

#### Time

- one class period

#### What to do

1. Divide the class into 4 groups to carry out the experiment.
2. Get two 250 mls beakers.
3. Measure 100 mls of water and pour into each of the two beakers.
4. Put a tablespoon of salt into one of the beakers and stir until the salt has dissolved.
5. Label this beaker “salt water” and the other “fresh water”.
6. Pour some of the salt water into a smaller beaker or container until it is  $\frac{3}{4}$  full.
7. Add food colouring (whatever colour is available) to this salty water until it is dark.
8. Label the small container “salt water”.
9. Repeat Steps 6 and 7 with the fresh water. Make sure you use a different food colouring. Label the small container “fresh water”.
10. Use a dropper and add 5 drops of the coloured salt water to the large beaker of fresh water. Observe what happens to the coloured salt water. Does it mix with the fresh water? Does it float or sink? Draw a diagram to show what is happening using colours.
11. Use another clean eyedropper and add 5 drops of coloured fresh water to the clear seawater in the large beaker. What happens to the coloured fresh water? Does it mix with the seawater? Does it float or sink? Draw a diagram using colours to show what happened.
12. Write up the experiment in your science lab book in the standard scientific format and include answers to the following:
  - (i) Explain what happens when fresh water and sea water mix.
  - (ii) What happens when it rains out at sea?

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• SEREAD and ARGO. **Oceans Rising.**

## Activity Two: Weather Watch

**AIM:** To make simple equipment to measure weather conditions.

**Time**

- two class periods to prepare weather watch equipment and a week for observations and another class period to analyse results

**What to do**

1. Write the term WEATHER on the board and ask students what it is. Discuss and explain.
2. Pin on the board a copy of the weather report (from the Samoa Observer or the Meteorology Office).
3. Ask one of the students to read the report. Ask the students if they listen to the weather report on the radio or television. Discuss.
4. Ask students to identify the main features of the weather given: temperature, humidity, rainfall, wind, clouds. Discuss and explain.
5. Ask students about the units used to measure each and how they are measured. Discuss and explain.
6. Divide the class into four groups and assign a measurement for each group to be responsible for – temperature, rainfall, wind and clouds.
7. Teacher will prepare a wall chart for students to enter recordings each day for a week.

DATE	RAINFALL	TEMPERATURE	WIND	CLOUDS

8. When the week is over, discuss the weather chart and check with the weather reports from the meteorology office to see if your measurements were accurate.

**Step One:** Choose the site and the time

Choose a place near your classroom away from tall trees and buildings. A garden is a suitable place. The best time to record this information is around midday.

**Step Two:** Measuring temperature

**Materials needed:** thermometer

The thermometer is best placed about 1.2 to 1.5 m off the ground. It should be partly in the shade. Hang the thermometer off a fence.

The group responsible should check the thermometer and record the temperature at the same time each day for the duration of the activity.

Are the days getting hotter or cooler?

**Step Three:** Measuring rainfall

**Materials:** large plastic drink bottle, knife, measuring cylinder or ruler

1. Cut the top off the bottle just below the shoulder.
2. Turn the top upside down to make a funnel. Push this inside the cut off rim of the bottle.
3. Find a clear are of ground. Dig a small hole in the ground to fix the rain gauge in position. (Sand helps to keep it in place)
4. Use a ruler to mark a scale on the side of the bottle. The scale can be in cm or in mls of water.
5. At the same time each day, measure the amount of water in the container by either tipping it out into a measuring cylinder or measuring the height of the water in the bottle. (When the water is less than 10 mm, then you need to estimate.)
6. Tip out the water each day and record your readings in the class chart.
7. Are you getting more or less rains?

**Step Four:** Measuring cloud formations

Students in this group should recall their knowledge of types of clouds from science.

1. Observe the sky. What kinds of clouds are present? What do they look like? How high are they in the sky? What shape are they?
2. Record your answers on the weather-monitoring chart each day.
3. Do some clouds link to different weather such as rain or wind?

**Step Five:** Measuring wind

**Materials:** knife, shoe box, card, protractor, piece of 5 mm dowel (1 m long) – pin or peg fitted tightly into adjacent holes of two pieces to hold them together, tape, marker pen, book covering plastic, pen cap or end of a broken biro (big enough to fit over the dowelling).

1. Use the plan on the next page to draw out the wind vane and cut it out.
2. Score a line down the centre and fold in half.
3. Stick the folded halves together.
4. Cover one side of the wind vane with the protective plastic then fold the plastic over the other side.
5. Stick the pen cap to the vane.
6. Find a post or fence in the open.
7. Fix the piece of dowel to the post or fence. (Use clips if possible.) Make sure it is vertical and the weather vane spins freely when put on top.
8. Let the vane spin in the wind. It will spin in the wind and point to the direction the wind is coming from. Mark out the directions north, south, east and west.
9. Is the wind coming from the same direction each day?



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• SEREAD and ARGO. **What is climate.**

## Activity Three: Play acting

**AIM:** To produce & act a skit relating to an effect of climate change on Samoan society.

### Materials

- group work

### Time

- two class periods

### What to do

1. Brainstorm ideas about climate change:
    - what it is;
    - causes;
    - effects; and
    - solutions to minimise drastic effects.Discuss and explain.
  2. Divide class into five groups.
  3. Each group will produce a 5-minute skit or drama to illustrate an effect of climate change on Samoan society.
    - Groups may select any aspect :
      - (a) environment;
      - (b) agriculture;
      - (c) diseases;
      - (d) water supplies;
      - (e) coral reefs;
      - (f) people;
      - (g) natural disasters.
    - How will sea level rise or temperature increase affect life in Samoa?
    - It should also give some suggestions to ways in which these effects can be minimised.
  4. Give time for preparations and then each group to present their production and the others to ask questions and comment on all presentations.
  5. Activity may be carried out as a competition and other people may be invited either to judge or just to listen.
  6. Discussion of presentations
-

## fact sheet twenty three: Flooding

Floods are the most common and widespread of all weather-related natural disasters. Many communities in Samoa experience disruptive flooding from heavy rainfall on a regular basis. Floods have enough power to change the course of rivers, uproot trees, destroy property and put human life at risk. It is important to understand the causes of flooding and what can be done to reduce its harmful effects.

### **Types of Flooding**

#### 1. River Flooding

Flooding along rivers is a natural and inevitable part of life. Flooding in Samoa occurs each year due to large rains in the wet season (November to April). Torrential rains from cyclones or tropical systems can also produce river flooding.

#### 2. Urban Flooding

Urban areas exacerbate the effects of flooding, since natural floodplains and drainage paths are often replaced with impervious structures.

#### 3. Flash Flooding

Flash floods usually occur within a few minutes or hours of excessive rainfall. Most flash flooding is caused by slow-moving thunderstorms or heavy rains from hurricanes and tropical storms. You will not always have a warning that these deadly, sudden floods are coming.

#### 4. Coastal Flooding

Winds generated from tropical storms and cyclones or intense offshore low pressure systems can drive ocean water inland and cause significant flooding. Coastal communities are most at risk by these storm surges, rising tides and tsunamis produced by earthquakes or volcanic activity.

### **Influences on Flooding**

Apart from coastal flooding, there are two elements that determine the type and severity of a flood event:

1. rainfall - above the ground;
2. runoff - on the ground surface.

Rainfall varies in terms of intensity (rate of rainfall, measured in mm/hour) or duration (time over which rainfall occurs). Runoff is largely impacted by the degree of urbanisation in the catchment. While little can be done to influence rainfall patterns, human activities can have a large impact on the degree of runoff. Development that reduces infiltration into the soil, typical of urban areas can increase runoff 2 to 6 times over what would occur on natural terrain. At-risk catchments must be managed carefully to ensure that natural forests are not carelessly cleared and runoff is minimised.

Climate change is also expected to increase the severity of flooding. Not only are sea levels expected to rise, but there is likely to be an increase in the frequency and intensity

of rainfall events and cyclones. Communities who have experienced flooding in the past are likely to experience more frequent and more severe flooding in the future. It is important to learn the lessons of past flood events to prepare for flooding to come.

### **Previous Flooding in Samoa**

Flooding in Samoa is relatively common and has a long history. Severe floods occurred in Apia in 1939, 1974, 1990 and 2001. Recent “moderately severe flooding” occurred in February 2006 and January 2008. Cyclone Gina caused flooding in 1989, while old newspapers record other floods in 2000, 1991 (Cyclone Val), 1990 (Cyclone ‘Ofa), 1982, 1975 and 1974.

Damage in Apia was particularly severe on Easter Sunday 2001, when approximately 1,300 buildings were damaged, over 28,000 people were affected by water cuts, and the repair bill was estimated to have exceeded 11 million Tala. These floods rose very quickly as the result of heavy rain (200 mm in four hours) falling on the short and steep watersheds that flow through Apia.

### **Before a Flood:**

- do not build your house on flood-prone land;
- ensure drains and culverts are free from rubbish and debris;
- do not strip slopes or river banks of trees;
- know where to evacuate to in the event of a flood.

### **During a Flood:**

- watch for heavy rain;
- listen to the radio and act on any warnings;
- make sure your family and neighbours are also aware and keep in touch in case they need your help;
- avoid crossing a river, even in a vehicle;
- do not swim in the river, risk getting a disease or being swept downstream;
- boil water and cook all food;

### **After a Flood:**

- check and dry appliances and electrical wires;
- throw out fresh food that has been in contact with flood waters;
- boil drinking water.

\* MNRE, DMO Section Information.

## Activity One: Carbon Cycle

**AIM:** To learn the carbon cycle & its link to global warming.

**Materials**

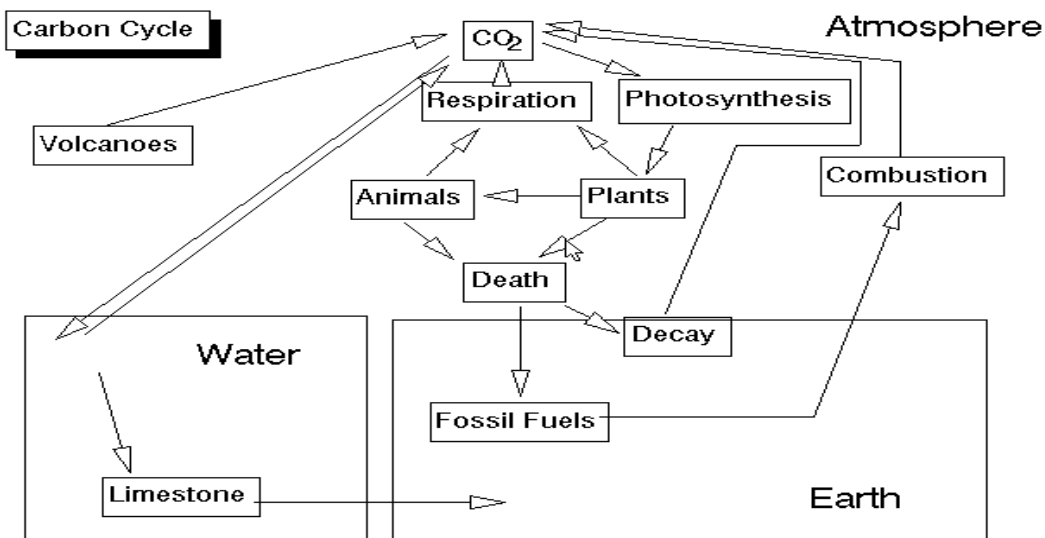
- newsprint
- Carbon cycle, other information from text books or internet

**Time**

- two class periods

**What to do**

1. Draw the Carbon Cycle on the board or on cardboard and show to the class.



Retrieved from: <http://www.marietta.edu/~biol/102/ecosystem.html> - Carbon Cycle

2. Discuss with class and explain the main processes: photosynthesis, respiration and combustion.
3. Arrange the class into 5 groups. Give each group newsprint to answer the following from their discussions:
  - (i) What will happen if plants are removed from the cycle?
  - (ii) What are fossil fuels? Name some examples.
  - (iii) Explain the relationship of the Carbon Cycle to the Greenhouse Effect.
  - (iv) How can we help to maintain the balance of this natural cycle?
  - (v) Name some alternative sources of energy that can replace fossil fuels.
  - (vi) Find out what a greenhouse gas 'sink' is.
  - (vii) How can sustainable agriculture and development methods, forestry and land management reduce global warming?
4. Present findings to the class and discuss.
5. Write a paragraph explaining the importance of the Carbon cycle to the Greenhouse Effect.

## Activity Two: Life on an Atoll

**AIM:** To find out about life on an atoll affected by sea level rise.

- Guest speaker from the Tokelau Office or community in Samoa. May have some people from Tuvalu or Kiribati as well.  
(Teacher should inform Guest about what to talk about. May ask for visual materials such as videos, photos of the atoll. Extra material may be obtained from the New Zealand High Commission.)

### Materials

- Guest speaker resources, newsprint, visual aids

### Time

- two class periods

### What to do

1. Before the presentation, revise what an atoll is. Recall knowledge from marine ecosystems about the types of coral reefs. Discuss and explain.
2. Ask the class to name some examples of atoll states in the Pacific. Discuss.
3. Ask the class what the significance of climate change is to atoll states? Discuss and explain.
4. Divide the class into five groups and give each group newsprint.
  - a. On the newsprint, draw your atoll and name it.
  - b. Mark on your atoll island:
    - i. where people live;
    - ii. where is your water storage;
    - iii. where is your waste disposed;
    - iv. where is the school, hospital, church;
    - v. where your crops are grown.
  - c. How many people live on your island?
  - d. What crops are grown and how are they grown?
  - e. What is the source of fresh water?
  - f. What kind of bathrooms is used and how is sewage disposed?
  - g. Name some problems of atoll life.
5. Each group to design questions to ask the speaker.
6. Guest speaker will then present his/her talk and class to listen and ask questions.
7. After the presentation, groups will present their atoll islands to the class and the guest speaker. Discuss and explain any issues.
8. Ask the class what will happen if the sea level increases? What can the atoll residents do to ensure that they will survive and maintain their lives on the atoll? Discuss and present findings to the class.
9. Display atoll islands in the classroom.

## Activity Three: Oceans Rising

**AIM:** To find out facts about water properties by experimenting.

**Time**

- one class period

**What to do**

1. Divide the class into 4 groups to carry out the following experiments. Two groups to do Part 1 and the other two to carry out Part 2 and share the results. Students may move around to observe what the other groups are doing.

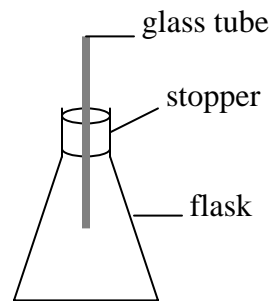
Part 1

Aim: To demonstrate how much water expands on warming.

Materials: flask, stopper/rubber bung, glass tube, food colouring, water, thermometer

Method:

1. Fill the flask almost to the top with water.
2. Measure the temperature of the water.
3. Add a drop of food colouring to the water.
4. Put in the stopper and tube. Press down firmly. Water should rise up the tube.
5. When water stops rising, mark the tube with a marker pen.
6. Put the flask out in the sun.
7. After 15 minutes take a look at the flask and measure how far up the tube the water level is now.
8. Measure the temperature of the water.



Results:

- measurements before and after: water level, temperature
- explain why the water moved up the tube
- by how many degrees did the temperature of the water increase?
- by how many centimeters did the level of water increase?
- a one degree temperature increase in the oceans will give an almost 80 cm increase in sea level. Describe and explain what this means.

Part 2

Aim: To demonstrate how much extra water is produced when ice melts.

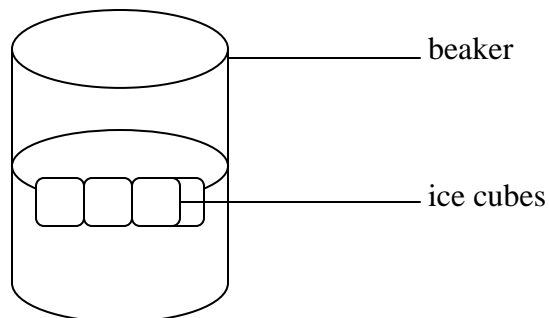
Materials: beaker, ice cubes, measuring cylinder

Method:

1. Measure 100 mls of water and pour into a beaker. Mark this level with a marker pen
2. Add 10 ice cubes and let them melt. What do you think will happen?
3. Observe the level of the water in the beaker. Has the height of the water changed once the ice cubes melted? Was there as much change as you expected?

Results:

- Explain what has happened to your experiment.
  - Explain what the effect of the Greenhouse Effect is on the oceans and floating ice caps.
  - Which one do you think will have the greatest effect in your lifetime on sea levels?
  - What evidence do you have to support your answer?
2. Groups to present their results to the class. Discuss and explain ideas.
  3. Students to write up the experiments in the standard scientific format in their lab books.



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## fact sheet twenty four: Kyoto Protocol

An international agreement known as the Kyoto Protocol has been negotiated to reduce the amount of greenhouse gas emissions and to try and agree about what to do about climate change, but the US is not participating in it.

Because of its high-energy consumption, the US has long emitted more carbon dioxide than any other country. Thus, while using large amounts of energy to achieve economic growth, the US and other wealthy nations have unintentionally burdened the rest of the world with a long-term problem. And many negative impacts of climate change are likely to be more severe for poorer countries that lack the resources to adapt. The US has more technological and financial resources than other nations. The role of the US in reducing its own emissions and sharing its technologies with other nations will thus be critical to the success of international efforts to limit climate change. Meanwhile, we do not have to wait for the government to take action. Some companies, governments and individuals have already committed to reducing their emissions of greenhouse gases without laws or treaties requiring them to do so.

Protecting the world's climate by stabilising atmospheric concentrations of greenhouse gases will require enormous reductions in current emissions.

Samoa has signed and ratified the Kyoto Protocol. As a non-Annex I Party to the Protocol, Samoa is not bound by specific targets for greenhouse gas emissions.

### Why So Much Controversy?

With such strong scientific consensus that global warming is real and is largely due to human activities, why is there so much controversy in the press and among the public? Why do some people keep insisting it is just an unproven theory? Some reasons involve communication breakdowns, but even more important is the deliberate campaign by special interests, including some in the fossil fuel industry, to undermine or cast doubt on the science.

Climate science can be confusing and is not easily explained in sound bites or brief newspaper articles. Many well-intentioned reporters are ill equipped to get the story right and their mistakes are often perpetuated as other reporters use previous articles as source material for new ones. Partly as a result of such problems, many people erroneously believe that global warming is caused by increased heat entering the atmosphere due to ozone depletion caused by CFCs.

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• EXTRACT FROM 1998 COMMUNIQUÉ. 1999 Forum Communiqué Thirtieth South Pacific Forum Koror, Republic of Palau 3 - 5 October 1999<http://chacmool.sdnf.undp.org/pacific/forumsec/docs/fc99.htm>

**YEAR 10**

**Activity One: Heat Transfer & Content**

**AIM:** To find out about heat transfer by experimenting.

**Materials**

- 2 containers of the same type
- 2 thermometers/sand/water

**Time**

- one class period

**What to do**

1. Divide class into 4 groups to carry out the experiment and collect their data.
2. Fill up your two similar containers; one with sand and the other with water.
3. Place a thermometer into the jar of sand. The bulb of the thermometer should be about 2 cm into the sand. Take the reading and record the temperature at the beginning of the experiment.
4. Repeat Steps 4 and 5 for your container of water.
5. Place the containers in the sun.
6. Record the temperatures after 10 minutes.
7. Repeat Step 7 two more times.

Time (minutes)	Temperature (°C)	
	Sand	Water
0		
10		
20		
30		

8. Move the containers to a shady place and record the temperature of the two at the start.
9. Leave for 10 minutes and measure the temperature.
10. Repeat again two more times and record your readings in another table similar to the one above.
11. Write up the experiment in the standard scientific format including the answers to the following questions.

**Questions**

- (i) Which of the containers had the greatest increase in temperature?
- (ii) Which of the containers showed the greatest drop in temperature?
- (iii) Explain what has happened to the two containers. Which of the water and the sand was able to hold more heat energy?
- (iv) What effect do you think this would have on our climate, particularly places by the sea?

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\* SEREAD and ARGO. **What is Climate?**

## Activity Two: Heavy Rains & Flooding

**AIM:** To use visual material & knowledge to write an essay about flooding.

### Materials

- photographs

### Time

- one class period

### What to do

1. Show the photographs below to the class showing recent flooding after heavy rains. (*Photos taken by Funefeai Oliva Vaai 25<sup>th</sup> Jan 2008. Retrieved from: MyFamily.com Falelalaga Website*)



2. Discuss photographs talking about the causes of the flooding, damage to peoples' properties and homes, damage to the environment, health & sanitation problems arising from flooding, what to do & who to contact for assistance, etc.
3. Students to write an essay on one of the following:
  - "Climate Change and its Effects on Samoan Society and Environment".
  - "Effects of urbanisation on climate change"
  - "Health problems related to flooding"
  - "Floods – a natural disaster"

## Activity Three: Research Project

**AIM:** To collect, select & interpret information by carrying out a research about climate change.

### Materials

- information from various sources including Internet

### Time

- one class period to discuss and explain project and then give enough time for groups to collect information
  - one class period for presentations
1. Arrange class into 4 groups. Assign an ecosystem to each of the groups (given below). Each group will work on a research project finding information about the following:
    - (i) What evidence is there that the earth is actually warming up?
    - (ii) What might be causing any global warming?
    - (iii) What effect might global warming have on the earth's inhabitants?
    - (iv) What can be done to prevent future global warming?
    - (v) To what extent is the Greenhouse Effect influencing our weather?
    - (vi) Identify interdependencies among plants and animals in your given ecosystem and explain them. Explore how climate change might affect these interdependencies and the ecosystem as a whole.

Ecosystems: Mangrove Ecosystem, Coral Reef Ecosystem, Forest Ecosystem, Freshwater Ecosystem.
  2. Groups to present information and whole class to discuss issues.
  3. Display group work.

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