



DEPARTMENT OF EDUCATION



CONSERVATION OF THE KIKORI RIVER BASIN

A TEACHER'S RESOURCE BOOK FOR PRIMARY SCHOOLS

SUPPORTED BY THE WORLD WIDE FUND FOR NATURE



The Silent Foundation
In aid of silent sufferers

CONSERVATION OF THE KIKORI RIVER BASIN

Issued free to all schools in the Southern Highlands, Hela, Enga, Gulf and Western Provinces and interested schools in Papua New Guinea.

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PNG Country Office, PO BOX 90, BOROKO, NCD, Port Moresby Office
Section 75, Allotment 12,
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Tel: +675 325 7988 | Website: https://www.wwfpacific.org/about/papua_new_guinea/
Email: infor@wwfpacific.org / esimon@wwfpacific.org

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Written by: World Wide Fund For Nature (WWF)

Coordinated by: Kafuri Yaro and Elizah Maso Simon of WWF Pacific, Papua New Guinea.

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- Naho Someya Tubo Primary School
- Oscar Otto Waro Primary School
- Ezra Dickson Lake Kutubu Primary School
- Patrick Sewia Inu Primary School Head Master

Abraham Dosabo School Inspector Basic Education, Zone 2 of Nipa-Kutubu



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Foreword by Secretary for Education

I am pleased to introduce the teacher resource book on the conservation of the Kikori River Basin, developed by the World Wide Fund for Nature (WWF) in collaboration with the Department of Education. This book serves as a valuable tool for primary school teachers in the Southern Highlands, Hela, Enga, Gulf, and Western Provinces of Papua New Guinea.

As the Secretary for Education, I strongly believe in the importance of environmental education and its integration into the curriculum. Our natural resources and ecosystems are the foundation of our country's cultural heritage, livelihoods, and future development. It is vital that our students develop a deep understanding and appreciation for the environment from a young age.

This resource book provides teachers with a comprehensive guide to incorporating concepts of biodiversity, conservation, and sustainable natural resource management into their classrooms. It aligns with the primary school curriculum, specifically focusing on the subjects of Science and Social Science. However, it also offers opportunities for interdisciplinary connections with other subjects such as English, Mathematics, and Arts.

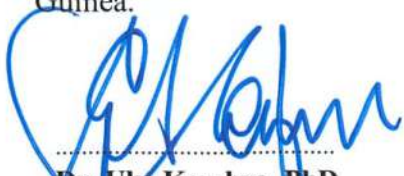
One of the notable strengths of this resource book is its recognition and integration of traditional knowledge and practices. It acknowledges the importance of indigenous wisdom and cultural heritage in environmental stewardship. By incorporating traditional knowledge, students are encouraged to develop a holistic understanding of their environment and the interconnectedness of human beings with nature.

I commend the efforts of the World Wide Fund for Nature and their partners in developing this resource book. Their dedication to conservation, sustainable development, and community engagement is exemplary. I also extend my appreciation to the teachers, educators, and local communities who have contributed their knowledge, expertise, and time in reviewing and trialing the content.

All primary school teachers in the Southern Highlands, Hela, Enga, Gulf, and Western Provinces are urged to utilize this resource book effectively in their classrooms. It provides a wealth of information, engaging activities, and sample lessons that will enhance students' understanding of the Kikori River Basin environment and the importance of biodiversity conservation.

By incorporating the lessons and values outlined in this book, we can empower our students to become responsible and environmentally conscious citizens. They will be equipped with the knowledge and skills needed to make informed decisions, protect our natural resources, and contribute to sustainable development in their communities.

I encourage teachers to embrace this resource book as a catalyst for transformative education. Together, let us inspire the next generation to be champions of environmental conservation, caretakers of our precious ecosystems, and leaders in building a sustainable future for Papua New Guinea.



Dr. Uke Kombra, PhD
Secretary for Education
Department of Education

Message from the Regional Director, WWF-Pacific

World Wide Fund for Nature (WWF), founded in 1961, is an international non-government organization (NGO) present in over 100 countries, 58 offices, 5000 plus staff with 5 million supporters around the world. In 1994, WWF was formally registered in Papua New Guinea, and we are known as WWF Pacific, Papua New Guinea Country Programme.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature by: conserving the world's biological diversity; ensuring that the use of renewable natural resources is sustainable; and promoting the reduction of pollution and wasteful consumption.

WWF priority places include the Kikori River Basin, which encompasses five provinces of Papua New Guinea; Enga, Southern Highlands, Hela, Gulf and Western.

WWF has worked in Kikori River Basin since the 1990s and we remain committed to working towards protecting and conserving this important area in order to safeguard livelihoods of future generations through recognizing and securing land tenure and user rights of local communities; traditional land and natural resources and their important contributions to conservation

This Teachers Resource Book is developed to promote conservation of Kikori River Basin's natural wealth and to share knowledge by supporting the Papua New Guinea Department of Education school curriculum. The Teachers Resources Book incorporates the biological research data, publications, and case studies of local communities and the WWF's Conservation work in the Kikori River Basin.

The Teacher's Resource Book has six learning units all linked to natural and social science subjects in the primary school curriculum. It is intended to be taught in the primary schools in those five provinces with specific links to Kikori River Basin's natural environment and conservation work carried out by WWF and communities who call this place home.

On behalf of WWF-PNG, we look forward to supporting PNG's communities and the natural resources they depend on.

Thank you,



Dr. Mark Drew (PhD)
WWF-Pacific
Regional Director



1. INTRODUCTION

This resource book was developed specifically for primary school teachers in the Southern Highlands, Hela, Enga, Gulf and Western Provinces. This book will enable teachers to understand and implement concepts (knowledge) about the natural resources and the environments found in and around the Southern Highlands, Hela, Enga, Gulf and Western Provinces.

It is important that children learn and know about the natural resources and the environment and be able to respect and value them. They will learn about the importance and the uniqueness of the biodiversity, their habitat and their role in the existing ecosystem, and the interdependence of people and the environment. They will be able to cultivate right attitude and knowledge towards maintaining sustainable natural resource management and biodiversity conservation, value human linkage with nature and interconnectedness, and be able to share this knowledge with their people in the communities and even stimulating learning for future career development.

About this book


The content in this resource book is linked to the primary subjects of Science and Social Science however; minor links can be made to English, Mathematics and Arts. This book is relevant to and can be used by teachers and students in similar communities in Papua New Guinea.

This resource book is intended for use by Primary School teachers in the Gulf, Enga, Hela, and the Southern Highlands communities of Papua New Guinea. The book contains information about biodiversity, conservation and sustainable management of natural resources in these communities. It is important for you to build and extend your knowledge about the biodiversity; it is important for conservation and sustainability. It is also important to understand the threats and challenges faced by our natural resources, the value our biodiversity holds for its people, that will allow you to transfer this understanding to your students.

The resource book also reinforces the importance of traditional knowledge and culture, role of youth and women in sustainable development, sustainable livelihoods, eco-tourism as an alternative income generating activity and empowering the people and communities in the project site.

This resource book contains six units:

- The Kikori River Basin Environment
- Our Natural Environment
- Biodiversity and Conservation
- Climate Change
- Waste, Pollution and Exploitation

- 
- Conserving and Managing Our Environment

Each unit is divided into topics. There are three (3) topics in Units 1, 2 and 5, and two (2) topics in Units 3, 4 and 6. Each unit has an introduction containing some background information about the unit. The topics are supported with two sample lessons which models a variety of teaching and learning strategies. These lessons contain learning objectives, key ideas about the content and learning activities with sample assessment ideas.

You do not need to use all these activities. You can select the ones that are suitable and appropriate for your class. You may adapt the ideas in the lessons also and develop activities that may link to other relevant subjects.

Student activity sheets provide more information for you. Share feedback on this resource with your colleagues.

The lesson activities help students to develop and further enhance the following skills:

- *Communication* - for example: oral and written reporting and presentation, reading and listening, note taking, summarising, decision making and exchanging ideas.
- *Critical thinking* - for example: problem solving, reasoning and analysing.
- *Mapping* - for example: reading, understanding and interpreting information on maps and drawing maps.
- *Research* - for example: writing survey questions, interviewing, collecting, collating and analysing data, retrieving information and reporting and presenting data.
- *Creative and innovative capability* - for example: planning, designing, implementing, monitoring and evaluation.
- *Social development and interpersonal* - for example: working co-operatively and collaboratively and using appropriate communication skills when working in pairs, with partners or in a team.

Traditional knowledge

This book acknowledges and values traditional and cultural knowledge and best practices in conservation and biodiversity management and links these to modern conservation issues and practices. It endeavours to instil in students value and respect for traditional and cultural knowledge and practice which continue to hold true for them now and in their futures.

You have a responsibility to nurture these values through your lessons with the help of activities designed in each of the topics in this book. Build knowledge based on the students' prior knowledge which includes traditional knowledge from their cultural activities.



How to use this book

Here are some points to take note of:

1. Materials needed for activities are listed in the lessons. The length of lesson time may vary from one school to another. You are advised to deal with your time according to the needs of your students.
2. You are encouraged to try out the suggested activities, adapt or modify them to suit the availability of resources, your experience and your class. Many of the activities require students to produce things, so be prepared for a lot of resources and beautiful decorations for your classroom.
3. Sample assessment activities are included in some lessons. You are encouraged to try these out and use the feedback to improve the task. Make sure that you include the sample assessment activities in your assessment plan. Follow the same assessment procedure used in the Primary Teacher Guides.
4. For all activities that require field trips, you are responsible for the following:
 - a) Setting a date.
 - b) Obtaining permission from the head teacher, parents or guardians and the people at the field trip site.
 - c) Setting the time. If you are going to the mangrove forest, then make sure it is at low tide. You will need tide information available from the weather office, radio and newspapers.
 - d) If the site is further away, organise transport and how it will be paid.
 - e) Prepare field trip notice and consent forms for parents' approval, including material needed for the trip, time of trip and time returning, cost of trip, and students' food and clothing.
 - f) Organise extra helpers to supervise students – other teachers, parents and school committee members.
 - g) Prepare a first aid kit and organise equipment and other resources needed for the trip.
 - h) Make sure students are well informed of the purpose of the trip and to have respect for all living things at the site. Remember: Look before disturbing.
 - i) Return all plants and animals to their habitats after observing them.
 - j) Replace any rocks which have been moved or turned over.
 - k) Make sure the students are aware of the dangers of rising tide and poisonous animals.
5. For all activities that require guest speakers, you are also responsible for:
 - a) Obtaining permission from the head teacher for the activity.
 - b) Organising with the person or organisation about the time, date of activity and what precisely is expected of the speaker. That is, the topic and the information that needs to be relayed to the students.
 - c) Writing a formal letter and speak personally to the guest.

- d) Preparing students for the activity by giving them background information and what they are expected to do during the presentation.
- e) Nominating a student to say a word of thanks and appreciation after the presentation.

2. GENERAL AIMS

The aim of this Teachers Resource Book is to ensure that students will be able to; develop a knowledge for and appreciation and respect for their natural environment.

- Develop an understanding for the need to protect, conserve and sustain their unique resources for the benefit of their people and communities.
- Develop effective communication skills in problem solving and decision making.
- Appreciate and value their cultural heritage that identifies their original existence.

3. LINKS TO PRIMARY CURRICULUM

UNITS	TOPICS	SUBJECT
1. The Kikori River Basin Environment	1. The Kikori River Basin 2. Ecological Importance 3. Importance to Communities	Community Living Environmental Studies Science & Social Science
2. Our Natural Environment	1. The Physical Environment 2. Terrestrial Ecosystem 3. Aquatic Ecosystem	Community Living Environmental Studies Science Social Science
3. Biodiversity and Conservation	1. What is Biodiversity? 2. What is Conservation?	Community Living Environmental Studies Science Social Science
4. Climate Change	1. The Causes and Effects of Climate Change 2. Taking Action	Community Living Environmental Studies Science Social Science
5. Waste, Pollution and Exploitation	1. What is Waste? 2. What is Pollution? 3. What is Exploitation?	Community Living Environmental Studies Science Social Science
6. Conserving and Managing Our Environment	1. Traditional and Modern Conservation Practices 2. Conserving and Managing the Kikori River Basin Resources	Community Living Environmental Studies Science & Social Science

4. TEACHING & LEARNING STRATEGIES

A variety of teaching and learning strategies can be used to make your lessons interesting, fun and enjoyable.

The table below describes some teaching and learning strategies. You can also add others you find useful to this list.

Teaching and Learning Strategy	Explanation
Brainstorming	Brainstorming is used to generate ideas about a topic. All ideas are accepted. Discussions then take place, usually in groups or as a whole class. Points are evaluated and organised. Any incorrect ideas, such as listing soil and air as living things, are corrected.
Concept Mapping	<p>Concept mapping helps teachers to evaluate students' understanding of a concept. Key words about the topic, theme or concept are generated. These are linked using connecting phrases or words. In this example, students are encouraged to reflect on their prior knowledge about the Kikori River Basin.</p> <pre> graph TD KB([KIKORI RIVER BASIN]) --- FB([Find building materials]) KB --- PF([Provides food]) KB --- DO([Dissolved oxygen]) KB --- DN([Dissolved nutrients]) KB --- MC([Mud crab]) KB --- PNT([Pig-nose turtle]) KB --- DS([Disperses seeds]) KB --- PL([Plants]) KB --- PW([Provides water]) KB --- HH([Helps Human]) KB --- GF([Gives food e.g. fish]) HH --- AN([Animal]) HH --- HA([Home for animals]) HA --- PNT HA --- MC </pre>
Problem Solving	<p>Problem solving encourages students to investigate an area of interest and establish strategies and actions to solve or minimise the problem. This helps students to develop critical and analytical thinking skills and to apply decision-making and problem-solving skills in real life situations.</p> <p><i>Example:</i></p> <ol style="list-style-type: none"> 1. Identify problems for discussion. 2. Discuss ways to solve the problem. 3. Consider the consequences of applying a particular strategy in trying to solve a problem. 4. Consult experts and other resource personnel for assistance. 5. Decide and apply corrective measures to correct the problem and take actions for planning and implementation.
Investigation	This is a scientific process where questions are structured with clear steps to solve a problem. Scientific knowledge and skills are applied to reach a solution.

	<p>Example: Soil Investigation</p> <p>Members _____ Class _____ Date _____</p> <ol style="list-style-type: none"> Describe where the soil is from: <ul style="list-style-type: none"> Where was your soil site? What was growing on this site? Was it level or on a slope? What other things did you notice? Describe the soil: <ul style="list-style-type: none"> What color is it? How does it feel? Roll some between your fingers. What do the largest and smallest soil particles look like? How does your sample compare to the other soil samples? Describe what is in the soil <ul style="list-style-type: none"> What are some of the things that make up your soil? Add water to the soil and allow it to settle for at least a day before doing this activity. Draw what the layers look like. How do they compare to the other samples? Write a summary of your findings and report to your class.
Observation and Collecting Information	<p>Students are actively involved or engaged in using all their senses: seeing, touching, smelling, tasting and hearing. They use skills of observing and recording.</p> <p>Example: Nature Observation Sheet</p> <p>You will need a simple map of the area you will be visiting and multiple copies of the nature observation sheet.</p> <p>Name _____ Date _____</p> <p>Exact place _____</p> <p>What I saw _____</p>
Projects	<p>These are short or long term activities which individuals or groups of students do over a number of lessons or in their own time.</p> <p><i>Examples of projects are:</i></p> <ul style="list-style-type: none"> studying marine life looking at pollution and its effects looking at wastes and ways of managing them studying the life cycle of a particular plant or animal making an aquarium or terrestrial model collecting pictures of different plant or animal species (a sample given below) monitoring climate in relation to seasonal plants such as mango, yam and peanuts. <p>Research Project</p> <p>Name _____ Class _____ Date due _____</p> <p>Topic: Birds of Kikori River Basin</p> <ol style="list-style-type: none"> Find a picture of a bird found in Papua New Guinea. Draw the bird and name some of its parts. Write its name in your vernacular, Tok Pisin, Motu or English. Does your bird have short, medium or long legs? Does your bird swim in the sea or freshwater? Does your bird live in trees or on the ground? <p>Summary</p> <p>Birds are living things that have f _____ over their bodies. Instead of front legs they have a pair of w _____.</p> <p>Most birds use these to f _____. Some birds cannot fly. Birds lay e _____ in n _____.</p>

Performances

At Lower Primary, students are still at the stage where they like to move, talk or play a lot. Activities such as performing mimes, role plays or reciting poems make learning fun and meaningful as students become involved in sharing their opinions and creativity about their environment.

Example:

Topic: Rainforests Introduction

1. Distribute a variety of rainforest pictures. Students could collect these as homework.
2. Brainstorm what students know about rainforests.
3. Display colorful letter blocks on front table.

Body of lesson

4. Teacher models acrostic poems.
5. Class discussion to stimulate ideas for poems about rainforests.
6. Students use letter blocks to create acrostic poems.

Conclusion

7. Choral or group recitals of poems.
8. Add pictures, publish and display poems.
9. Create short role plays from poems.

Example of an acrostic poem

Completely
Original and
Natural
Sustainable and
Enriched
Rainforests that are
Very
Attractive and of
Top
Importance
Of course to
Nature

Presenting Information

This normally happens after an observation or finding out activity.

Students put their ideas together and then identify ways of presenting their findings. Presentations may be in the form of charts, posters, big books, tables or in oral form.

Example: Presenting information using a table.

Things I found in my school garden;

Insects	Worms	Plants for eating	Other plants	Birds
grasshopper	Red worm	tomato	grass	crow
spider				
beetle				

Students can also draw diagrams of these things on a chart or make a big book.

Writing Activities

Students can write short stories, poems, reports or diary entries about daily activities, explanations about an event, points to report in class, findings in an activity done outside the class and articles for their notice board.

Example:

Things I did during World Environment Day

	<p>From 8:00am to 10.00am I</p> <p>From 11.00am to 12.00 noon I</p> <p>From 1.00pm to 3.00pm I</p> <p><i>Students could draw pictures about these events here.</i></p>
Games about the Environment	<p>You can create many environmental education games for students or they can make up their own.</p> <p><i>Examples:</i></p> <ul style="list-style-type: none"> • make a model of a rubbish monster • compose animal songs • make puppets to show how animals move • make up riddles about things in the environment (who am I?) • build a food web by students joining hands and acting as living things in the food web • search for sounds • create word games (a sample given below) <p><i>Find the words hidden in the puzzle</i></p> <p>p g l a s s p y a c t i o n l m p m e t a l a c e r u b b l s h o u c a r e i n r e s p e c t e</p> <ol style="list-style-type: none"> 1. Copy the word puzzle on a piece of paper or on the chalkboard for everyone to see. 2. Brainstorm some of the things in the environment. 3. Students try to find some of these words to make them stand out. <p>Answers: <i>rubbish, glass, metal, action, care, respect</i></p>
Excursions and Field Trips	<p>Excursions and field trips really are <i>schools without walls</i>. They are useful and positive environmental activities. They help students to understand the relationships between humans and other living and non-living things in their environment. In any trip outside the classroom, it is important that safety precautions are taken and all students are well-informed. Some examples of sites for field trips are:</p> <ul style="list-style-type: none"> • road construction site • wildlife or rainforest habitat • botanical gardens • fish factory • local community water system • oil refinery or oil field • coastline or beachfront • mine site • logging site • school garden • city rubbish dump • National Museum. <p><i>Example:</i></p>



	An interview questionnaire must be used during an excursion. This questionnaire is designed and given to students before going on an excursion.
Debates	<p>Students present their arguments in a formal debate setting. Groups can be those for, and those against the topic. Other students can form research teams to assist each side with their preparations and others can form the judging panel who will judge the debate.</p> <p><i>Example:</i> After forming the groups, students can use their experiences from field trips and excursions to proceed with their preparations for the debate. Students should be encouraged to express themselves in the language with which they are most familiar.</p>



5. THE UNITS AND TOPICS

UNIT 1: THE KIKORI RIVER BASIN ENVIRONMENT



Photo: Lake Kutubu/Kyaro@WWF/2019

TOPIC 1: THE KIKORI RIVER BASIN

1.1 Introduction

This unit introduces you to the Kikori River Basin environment. The main focus is to know and understand your own environment so that you are able to successfully transfer this knowledge to your students. You will also develop knowledge about and understand the ecological importance of the natural environment and its unique inhabitants. The knowledge about ecology and the inter-linkage with communities in the Kikori River Basin are very important concepts.

1.2 Where is the Kikori River Basin?

The **Kikori River Basin (KRB)**, also known as the **Great Papuan Plateau**, encompasses five provinces of Papua New Guinea - Enga, Southern Highlands, Hela, Western and Gulf Provinces, and covers five districts and 18 local level governments with a population of 204 100 (NRI, March 2010).

The **Kikori River Basin** is 200km in length and stretches from sea level (0m) to about 3000m above sea level. This area contains important biodiversity and unique cultures and people.

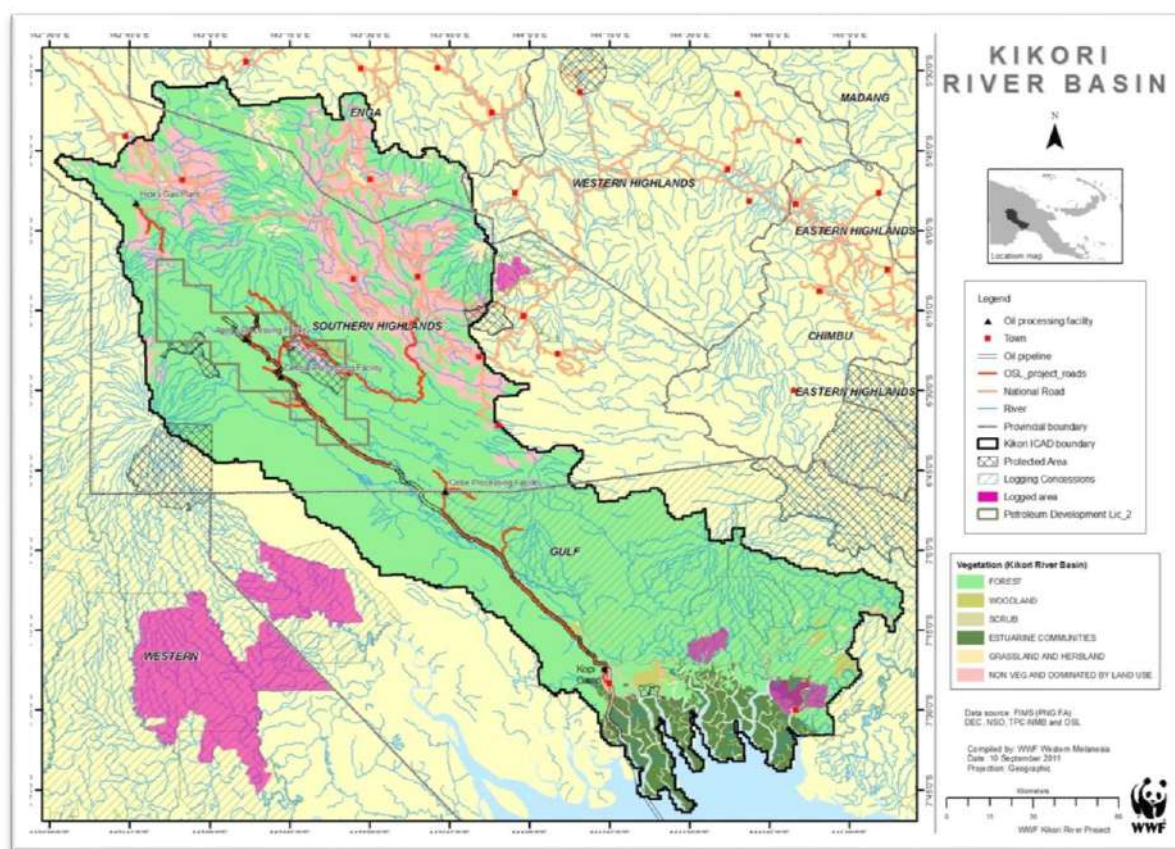



Fig. 1 This is a map of the Kikori River Basin encompassing the five provinces

The basin boasts 2.3 million hectares of tropical rainforest hosting fragile landscapes and ecosystems.

Since 1995, the WWF, Papua New Guinea Country Programme has been working in the region. Through stakeholder support from local communities, respective provincial government authorities, Conservation & Environment Protection Authority (CEPA), and Oil & Gas Industries (Oil Search & Exxon Mobil) WWF has been able to address environment and biodiversity conservation challenges while building the local capacity in ensuring sustainable natural resource management through alternative livelihood and income generation options in the Kikori River Basin.

WWF supported the establishment of 103,075 hectares for community conservation areas. The five inter-connected community conservation areas are:

1. Lake Kutubu Wildlife Management Area
2. Libano Arisai Wildlife Management Area
3. Libano Hose Wildlife Management Area
4. Sulamesi Wildlife Management Area
5. Neiru Wildlife Management Area



These community conservation areas were gazetted through Conservation and Environment Protection Authority (CEPA).

1.3 The World Wildlife Fund for Nature in the Kikori River Basin

In 2013-2015, the WWF work was focused on developing the Kikori River Basin Conservation Blue Print. This Blue Print provides guidance to future land use planning. This enables all stakeholders to plan for development without harming the most valuable areas of critically important biodiversity which are of value locally and globally. Dialogue with government departments is ongoing to gain support and influence policy change and adoption of sustainable land use practices in respective land development sectors and industries.

WWF focuses on the following key strategies:

1. Sustainable landscape management including forest, land-use and development planning
2. Responsible forest management
3. Network of locally managed conservation areas
4. Flagship species conservation
5. Community livelihood generation
6. Climate change adaptation and environment education awareness.

The key strategies listed above will make sure the protection and conservation of the KRB environment occurs. *In terms of the protection of the environment, these strategies mean the following:*

1. *Sustainable landscape management including forest, land-use and development planning:* This strategy is for improved governance and more responsible actions in land use, trade and investment of agriculture and forestry, Mining, Oil & Gas and Government priority infrastructure development projects.
2. *Kikori River Basin world heritage site nomination:* There is a commitment to protect the sustainability of the region by 2030 and beyond. This will be carried out by coordinating resources with key stakeholders including businesses, NGOs, local communities, religious groups and local level, provincial and the national governments. The Government through Conservation & Environment Protection Authority (CEPA) is to review and progress inscription of the KRB to UNSECO World Heritage Site status.
3. *Flagship Species Conservation:* Develop the Bird of Paradise and Pig-nosed Turtle Management Plan and, implement sustainable forest management practices to maintain their populations. This is linked to the Kutubu Kundu Digaso Festival and Eco-tourism activities.
4. *Sustainable Income Generation:* Improve sustainable income generation and the cultural use of the Kikori River Basin forest. Provide the protection of iconic species and landscapes for the betterment and livelihoods of the communities. Key livelihood and

income generation activities to be developed and linked to the Kutubu Kundu and Digaso Festival and eco-tourism activities such as bird watching, honey bee farming linked to Mountain Honey Ltd in Goroka, Easter Highlands Province, micro-finance schemes - village savings and loans associations, homestay guest house, and community eco-forestry and enterprise linked to the Forest Stewardship Council Forest Certification and long term certified timber markets.

5. *Environment Education Programme:* The environmental education and cultural practices programs will be developed and implemented in schools within the Kutubu region. This is to promote conservation and sustainability of the regions' natural resources and to share this knowledge at the annual Kutubu Kundu and Digaso Festival.

WWF continues to provide support for the development of livelihood and income generation activities for local communities. Initiatives for livelihood activities have already begun in Eco-tourism, community eco-forestry enterprises, food security, and climate change adaptation.

1.4 The Kikori River Basin – A World Heritage Site

By 2030, the KRB will be declared a World Heritage Site and the forest cover in high conservation value areas (HCVAs) as identified in the KRB Conservation Blueprint.




Fig. 2 The unique cultures and landscape of the Kikori River Basin

What is a World Heritage Site?

World Heritage Sites are places that belong to all the peoples of the world regardless of where they are located. Places as unique and diverse as the Serengeti Plains of East Africa, the Pyramids of Egypt, the Great Barrier Reef in Australia and the Baroque cathedrals of Latin America make up our world's heritage. They have universal value that exceeds the value they hold for a particular nation. What makes the concept of World Heritage exceptional is its universal application. World Heritage sites are declared under the United Nations (UN) agency called UNESCO.

The United Nations Education, Scientific and Cultural Organization (UNESCO) is a specialized agency of the United Nations (UN) based in Paris. UNESCO seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be of outstanding universal value to humanity. This is embodied in an international treaty called the *Convention concerning the Protection of the World Cultural and Natural Heritage*, adopted by UNESCO in 1972. Papua New Guinea is a signatory to this convention in 1979.



UNESCO pursues its objectives through five major programs:

1. Education
2. Natural sciences
3. Social and human sciences
4. Culture
5. Communication/information.

These programs then sponsor key projects that include:

1. Literacy
2. Technical and teacher-training programs
3. International science programs
4. Promotion of independent media and freedom of the press
5. Regional and cultural history projects
6. Promotion of cultural diversity
7. Translations of world literature
8. International cooperation agreements to secure the world's cultural and natural heritage (World Heritage Sites) and to preserve human rights.

The World Heritage List developed from one of the projects above recognizes the most important examples of cultural and natural heritage globally. World Heritage areas are a legacy to all people of the world and their outstanding universal values are protected for future generations. These sites are places that are important to and belong to everyone, irrespective of where they are located.

By *Outstanding Universal Value* means having cultural and/or natural significance which is so exceptional and exceeds national boundaries. These areas are also found to be of common importance for present and future generations of all humanity. A candidate site for World Heritage nomination shall be of Outstanding Universal Value.

PNG National Heritage

There are also current and proposed World Heritage Sites in PNG. The Kuk Early Agricultural Site near Mount Hagen in the Western Highlands Province is PNG's first world heritage nominated site. This site consists of a 116 ha of swamps which are 1,500 meters above sea-level. Archaeological excavation or digging has revealed the landscape to be one of wetland reclamation or recovery work almost continuously for 7,000 and possibly for 10,000 years. It contains well preserved archaeological remains demonstrating the technological rise which changed plant exploitation to agriculture around 6,500 years ago.



Fig. 3 A photograph of the Kuk Early Agricultural Site.

Kuk is one of the few places in the world where archaeological evidence suggests independent agricultural development and changes in agricultural practice over such a long period of time. The archaeological evidence at Kuk represents an outstanding example of traditional New Guinean land-use, namely various types of plant exploitation and different types of cultivation, that represent changing human environment relations over ten millennia.

Similarly, the Kikori River Basin is home to unique species of flora and fauna and, important physical natural landmarks. Therefore, the protection of the Kikori River Basin environment is very important for the livelihoods of its future generation.

In 2006, Papua New Guinea appointed seven National Heritage Sites to UNESCO which were enlisted under World Heritage Site *Tentative List* for nomination for World Heritage. These sites are:

1. The Sublime Karsts of Papua New Guinea (Nakanai Mountain Ranges, Muller Plateau, The Hindenburg Wall)
- 2. Kikori River Basin/Great Papuan Plateau**
3. Kokoda Track and Owen Stanley Ranges
4. Trans-Fly Complex
5. Milne Bay Seascape (Pacific Jewels of Marine Biodiversity)
6. Upper Sepik River Basin
7. Huon Terraces – Stairway to the Past

LESSON 1A - JUNIOR PRIMARY

Name of Lesson: What's in my Environment?

Objectives: By the end of this lesson, students can:

- Describe their immediate and surrounding environment.
- Name and describe some plants and animals in their environment.

Key Knowledge:

1. Living and non-living things in the environment.
2. The environment is home to many living things.
3. Different plants and animals are found in different areas of the environment.

Materials Needed: Factsheets with matching activity, shell book or big book stories about the environment.

Preparation: This activity can be carried out as a group work comprising of 4-5 members.

Activity: Nature Walk - Take the children out for a 'nature walk' on a good sunny day. This activity may also require you to make prior preparations. Ask the children to observe and identify different plants, animals and other objects during the walk. Back in the classroom, students will draw pictures of what they saw and compile a picture booklet. For example:



As a follow up activity, ask the children to name different things that they saw during the nature walk. For example, orchid, butterfly, bird, river, stream, lake, breadfruit trees, etc.

Evaluation/Homework: Ask the class to orally describe the kind of environment they visited during the nature walk. For homework, the children can complete drawing and colouring the pictures of what they saw. These can be hung or taped on and around the classroom walls.

LESSON 1B - JUNIOR PRIMARY

Name of Lesson: Plants and Animals in my Environment.

Objectives: By the end of this lesson, students can:

- Identify and name plants and animals that live in different habitats.
- Explain why a plant or an animal lives in a particular habitat.

Key Knowledge:

1. Animal homes are called habitats.
2. Types of habitats within their environment.
3. Some animals have more than one home.

Materials Needed: 4 - 5 pictures of mixed terrestrial and aquatic plants and animals, sets of habitat posters, shell book or big book stories about the environment, factual information readers about plants and animals

Preparation: This activity can be carried out as a group work. Ensure that the group has a leader, a scribe and presenters.

Activity: Animal Habitats - Have a display of pictures of plants and animals on the charts or posters. Divide the class into 4 or 5 groups depending on the number of posters you have displayed. Ask each group to choose one of these posters. Provide the following guiding questions and have the groups discuss the questions:

- (i) What is the name of the plant or animal?
- (ii) Where does it live?
- (iii) If it is an animal, what does it eat?
- (iv) If it is a plant, how does it get its food?

Have the groups discuss the questions and then do a group presentation to the whole class. During the presentation, assist the groups to point out the habitats of these plants and animals. For example, stream, forests or tree branches.

Evaluation/Homework: Ask the class to orally name the habitats that their plant or animal lives in. For example, green tree frog lives in the trees in the forest, river frogs live in the river, orchid grows on trees in the forest or a trout fish lives in freshwater or lakes.

For homework, the students can draw the habitat of their plant or animal and colour the picture.

Assessment Activity: Assessable task can be developed from the group work. You must make up your own criteria for marking.



LESSON 2A – SENIOR PRIMARY

Name of Lesson: World Heritage Site – Flagship Species of Kikori River Basin.

Objectives: By the end of this lesson, students can:

- Describe their immediate and surrounding environment.
- Name and describe some flagship species of the Kikori River Basin and their habitat.

Key Knowledge:

1. Environment of the Kikori River Basin.
2. Unique plants and animals species including flagship species
3. Kikori River Basin has many habitats

Resources: Factual information readers about environment and unique plants and animals and their habitat in Kikori River Basin.

Materials Needed: Pictures of flagship species, notebook, biros, butcher papers, markers, manila folder, paper binder, glue, scissors, and paper puncher.

Preparation: This is a group activity. Display the pictures of the flagship species on the board for all the students to see.

Activity: Group Discussion: Explain the activity clearly to the class ensuring that your instructions are very clear as to what students are expected to do in that lesson. Before the groups begin their activity: Divide the class into groups depending on the number of flagship species.

Put up the pictures on the board for them to identify and name together each species. Give an example for the first species and its habitat so that they can have a fair idea on how to go about describing the others. Give them a time period to work on, maybe 20 minutes. When they are done tell them to appoint someone in the group to do their presentation. After all the presentations are done, acknowledge their efforts and then put up the correct answers on the board and go through with them.

Evaluation/Homework: Remind the students about the importance of flagship species and their habitats. For homework, ask the students to identify and name some flagship species/important species in their local area.

Assessment Activity: Neatly compile a profile/portfolio of flagship species in a manila folder for assessment. You can develop your own criteria to assess individual or group work.

LESSON 2B - SENIOR PRIMARY

Name of Lesson: World Heritage Site – Importance of Kikori River Basin.

Objectives: By the end of this lesson, students can:

- Identify the unique people and culture of Kikori River Basin
- Explain why Kikori River Basin should be a World Heritage Site.

Key Knowledge:

1. Unique cultures and people.
2. Kikori River Basin as a World Heritage Site

Resources: Factual information readers about environment and the cultures and people of the Kikori River Basin.

Materials Needed: a stopwatch or clock, coloured flash cards to indicate different times, biros, notebooks, markers.

Preparation: This is a whole class activity and may take a double lesson. Appoint a chairperson, a timekeeper, and three judges including the teacher as the chief judge. Put the topic on the board or a chart paper so the class can read it together.

Activity: Class Debate: Explain the activity clearly to the class ensuring that your instructions are very clear as to what students are expected to do in that lesson. Before the groups begin their activity, they will have to listen to stories or read factual information about the Kikori River Basin culture, environment, and people.

Divide the class into two big groups. Ensure that each group appoints three students to speak. Each of these six speakers can decide who will go first, second and third for their groups. Put forward the topic for debate: *'Kikori River Basin Should be nominated as a World Heritage Site'*. Come up with a way to decide which group will argue for the topic and the group that will argue against it. Have each group brainstorm on their key ideas and supporting points. The points should be noted by each of their presenters. The chair person will control the debate. The time keeper will keep the time. Each speaker will be given only three (3) minutes to speak. The teacher and selected students can act as judges.

Evaluation/Homework: Remind students of the importance of the Kikori River Basin and its environments and the need for it to be protected for the benefit of the world. For homework, ask the students to write an argumentative essay that is in line with the debate topic.

Assessment Activity: The debate and the essay tasks are assessable activities. For the debate, you can record each group's performance. For the essay, you can record each student's writing skills. In both cases, you need to design and develop your own assessment task using a set of criteria.



TOPIC 2: IMPORTANCE OF KIKORI RIVER BASIN

The Kikori River Basin or the Great Papuan Plateau is a mixed cultural and natural site covering over 6% (2.3 million ha) of the landmass of PNG. The Kikori River Basin landscape includes the extinct volcano of Mt Bosavi, the cockpit and needle karst of the extensive Darai limestone, the remarkable Hegigio Gorge and the spectacular Wassi and Wawoi waterfalls.

The Kikori River Basin contains one of the largest remaining areas of undisturbed tropical rainforest in the Southern Hemisphere. The catchment spreads across nearly all forest types found in PNG, from alpine and montane forests in the north, to increasingly rare unharmed lowland forests in the south, to the largest block of mangrove forest in the Pacific.

The region is rich with about half the number of bird species of the entire North American continent. It hosts 24 of the 38 Birds of Paradise species, the world's only poisonous bird, the poisonous Pitohui, the world's rarest underground roosting bird (greater *Melampitta* or *Melampitta gigantea*), and the New Guinea flightless rail (*Megacrex inepta*), one of PNG's rarest birds. In addition, the area contains other species which are new to science or have been recently discovered. The region also hosts 20 undescribed orchid species recorded around Lake Kutubu area alone, and two undescribed species of palm (WWF unpublished report, 2005).

The region represents three centres of plant diversity, two endemic bird areas, and important sections of the New Guinea Central Range Montane Rainforest and the Southern Lowland Rainforest Ecoregions. Lake Kutubu forms part of the Lakes Kutubu and Sentani ecoregion. These are listed under Ramsar as the most unique lacustrine habitat in the New Guinea-Australia region and provide the entire habitat of 12 endemic fish species. Equally, Mt Bosavi and the Darai Limestone Karst are of particular importance with high levels of species which are endemic to the area, unique geological formations and extensive cave development.

Lake Kutubu and Mt. Bosavi is host to a number of culturally significant archaeological sites including important burial caves and cave paintings. The unique longhouse cultures of Mt Bosavi and Lake Kutubu extensively recorded in anthropological literature are existent in the area. Collectively, these natural and cultural resources put the Kikori River Basin on the map as an exceptional global treasure.

The Kikori River Basin is also the site of PNG's first major oil development. A partnership between the oil companies and WWF has led to the declaration of over 107 059, ha of protected areas. These include the Lake Kutubu Wildlife Management Area (4,924ha), Neiru WMA (3,984 ha), Libano-Arisai WMA (3,964ha), Libano-Hose (7,736 ha) and Sulamesi WMA (86,451 ha). Further interest has also been lodged by communities to establish protected areas within the Kikori River Basin.



LESSON 3A – JUNIOR PRIMARY

Name of Lesson: My Rainforest Habitat.

Objectives: By the end of this lesson, students can:

- Identify and name animals found in the rainforest habitat.
- Describe animals that live in the rainforest habitat.

Key Knowledge:

1. The environment is home to many living things.
2. The rainforest is a home to many different animals.

Resources: Different types of habitat posters, shell book or big book stories about different types of animals, factual information readers about particular animals.

Materials Needed: 4 - 5 pictures of mixed rainforest animals, clean butcher papers or A4 papers (can be used on one side), magazines, newspapers, scissors, a few pots of glue or sticky tape or staple machine with staples, coloured pencils, crayons or markers (if any available), activity and information sheets, lead pencils, note books.

Preparation: This activity can be carried out as a group work. Ensure that the group has a leader to collect their materials.

Activity: Rainforest Pictures: Take the children out for a 'rainforest walk'. (This activity may require you to make prior preparations). Develop a student fact sheet to help students observe, identify and match the pictures of plants and animals seen during the walk. On returning to the classroom, divide the students into 5 or 6 groups. Give each group a chart paper and have them draw pictures of what they have seen during the walk. Ask the groups to be creative and use paints or coloured pencils to colour their pictures.

Evaluation/Homework: Students are to display their work on the classroom walls. Ask students to name and describe three common plants or animals they found during their walk. For homework, groups can complete colouring or painting their pictures and displaying them.

Assessment Activity: The lesson activity is an assessable activity. You can record each group's performance based on a set of assessment criteria you have designed or developed.

LESSON 3B – JUNIOR PRIMARY

Name of Lesson: My Rainforest Animals.

Objectives: By the end of this lesson, students can:

- Explain the importance of some animals of the rainforest habitat.
- Construct graphs to show the number of different animals living in the rainforest habitat.

Key Knowledge:

- Some animal populations are getting smaller due to them being hunted for food.

Resources: Different types of habitat posters, shell book or big book stories about different types of animals, factual information readers about particular animals.

Materials Needed: 4 - 5 pictures of mixed rainforest animals, clean butcher papers or A4 papers (can be used on one side), magazines, newspapers, scissors, a few pots of glue or sticky tape or staple machine with staples, coloured pencils, crayons or markers (if any available), activity and information sheets, lead pencils, note books.

Preparation: This activity can be carried out as a group work. Organize all the materials on your desk for students to use, e.g. glue, crayons, etc. Ensure you have at least enough butcher papers for each group.

Activity: Poster: Have group leaders collect A4 sheets and a large piece of butcher paper from the teacher's desk. Before groups begin their activity, they have to choose one rainforest animal to write about. Each group will discuss about the animal they have chosen and appoint someone to write up their discussions. The groups will respond to the following questions:

- (i) Where does this animal live in the rainforest - for example, on tree branches, in the hollow of the tree, underneath the trees or bushes?
- (ii) What does it eat?
- (iii) Do people hunt this animal? Is it being hunted for food, decoration or medicine?

Animals of Kikori River Basin: BIRD OF PARADISE



- Lives on tree branches.
- Feeds on fruits and insects.
- Hunted for feathers.

One student can design borders of their poster while another write the title. Help the children choose a good title. For example, see the poster on bird of paradise. Each group present their poster. This should only take 2 or 3 minutes. The best completed posters can be placed on the school notice board for everyone's information.

Evaluation/Homework: Remind the class about the importance of the rainforest animals. For homework, students are to hang their posters on the classroom walls.

Assessment Activity: As an assessable activity, you can record each group's performance based on a set of assessment criteria you have designed.

LESSON 4A - SENIOR PRIMARY

Name of Lesson: My Habitat – Significance of the Kikori River Basin.

Objectives: By the end of this lesson, students can:

- Describe the significant plants, animals and landscape of that environment.
- List some flagship species of the Kikori River Basin.

Key Knowledge:

1. Kikori River Basin is a mixed cultural and natural site covering 6% of PNG's landmass.
2. Important geological and natural landscapes such as an extinct volcano (Mt Bosavi), extensive Darai limestone, remarkable Hegigo Gorge and spectacular Wassi and Wawoi waterfalls are found in Kikori River Basin.

Resources: Factual information readers about environment, animals, plants, cultures and people of the Kikori River Basin.

Materials Needed: Pictures or information about the Kikori River Basin environment, plants and animals.

Preparation: Read background information about the significant plants and animals in KRB. Put up pictures of the variety of plants and animals found in KRB. Flagship species may be put on a separate chart for comparison.

Activity: Class Discussion: Read together the background information brochures or leaflets on the landscape, plants, animals and people of Kikori River Basin. From this information, ask students to state different types of animals, plants and landscapes in the Kikori River Basin. Make a list of these on the blackboard as shown below:

ANIMALS	PLANTS	LANDSCAPES
Pignose Turtle	Orchids	Mt Bosavi Extinct Volcano
Bird of Paradise	Rhododendrons	Darai Limestone
Doria's Tree Kangaroo	Sagos Palms	Hegigo Gorge
Silky Cuscus	Oil tree or Digaso	Lake Kutubu
Giant Woolly Rat		Wassi Waterfalls
		Wawoi Waterfalls.

Have a discussion on why each of these animals, plants and landscapes are important. Explain that these landscapes are some of the most unique in the world and they also house some of the important and unique animals and plants which are found nowhere else in the world.

Evaluation/Homework: Remind students about the ecological and cultural diversity of KRB, the ecological and cultural importance of these and the need for it to be protected for the benefit of the world. For homework, students can write a poem about a special plant, animal, habitat or even their own favourite place in their environment.

LESSON 4B – SENIOR PRIMARY

Name of Lesson: My Habitat – Outstanding Universal Value of Kikori River Basin.

Objectives: By the end of this lesson, students can:

- Explain the ecological importance of Kikori River Basin.

Key Knowledge:

1. Kikori River Basin has one of the largest remaining tracts of undisturbed tropical rainforest in the Southern Hemisphere.
2. Kikori River Basin represents three Centres of Plant Diversity, two endemic bird areas, and important segments of the Global 200 New Guinea Central Range Montane Rainforest and the Southern Lowland Rainforest Ecoregions.

Resources: Factual information/readers about environment, animals, plants, cultures and people of the Kikori River Basin.

Materials Needed: Pictures or information about the Kikori River Basin environment & people.

Preparation: Read background information about the ecological importance of the Kikori River Basin. Put the topic on the board or a chart paper so the class can read it together and brainstorm i.e. *'The Importance of Kikori River Basin'*

Activity: Descriptive Essay: Clearly explain the activity to the class i.e. they are going to write a descriptive essay about the importance of Kikori River Basin (KRB). *Explain that a descriptive essay requires students to describe something by creating a written account of that thing. In this case, it is about KRB.* Put the topic of the descriptive essay on the chart or blackboard i.e. *'Why Kikori River Basin is Important'*. Have the class brainstorm on important facts about KRB including its ecology. Use pictures and background information about KRB to highlight its ecological and cultural importance. Students can then use these ideas to outline their essay for discussion. They can also begin writing in class and be given additional time over a few homework periods to complete their essay.

Evaluation/Homework: Remind students about the ecological importance of the Kikori River Basin environments and culture, and the need for it to be protected and preserved for the benefit of the future generations and the world. For homework, students can complete their descriptive essay.

Assessment Activity: The essay is an assessable task. Each student's writing skills are to be assessed individually. Design and develop your own assessment task using a set of criteria.

TOPIC 3: IMPORTANCE TO COMMUNITIES

The local people of the Kikori River Basin/Great Papuan Plateau catchment belong to at least 16 different ethnic groups who depend largely on the natural environment for subsistence and livelihoods. The forest has significant economic value for timber, ecotourism and non-timber forest products such as the recently discovered valuable fragrant resin eaglewood.

Large scale industrial economic development, the PNG LNG Project have commenced operation in 2010 and completed construction of key infrastructures by 2014. The oil and gas pipeline runs from the Southern Highlands through Gulf Province and the shipping ports (Wharves) built in the Central Province. The PNG LNG Project and other proposed development project roads, for example, Ihu Special economic Zone in the Gulf Province, Palm Oil Projects, and Commercial logging concession roads exerts extreme pressure on the environments of the Kikori River Basin. Many of these threats can only be addressed through coordination under the context of a catchment management programme now being initiated by WWF with key partners. A partnership of NGOs, government, and corporate interests offers a possibility for sustainable finance for effective management of the region.

The people of the Kikori River Basin comprise communities that still live subsistence lifestyles. Within the lower Kikori area of the Basin, communities thrive on fishing and making sago. Natural stands of sago and planted stands are harvested. Sago pulp is beaten down and washed using the natural sources of river water to extract the starch, the white sago powder which is the staple diet.



Fig. 4 Photo of Sago making in Lake Kutubu, SHP

The lower Kikori forms part of the Gulf of Papua that contains pristine mangrove and nypa palm habitats for freshwater prawns, mud crabs, shellfish and a variety of fish such as barramundi, mullets, catfish and jewfish. The idyllic lifestyle is heavily dependent on the clean and pristine freshwater and estuarine ecosystems that provide food, fish species and sago supplies.



Fig. 5 Fishing in Lake Kutubu, SHP.

The area is heavily water-logged and agriculture is not practised. The lower Kikori River Basin is heavily dependent on the protection and conservation of the upper part of the basin and the sources of river systems of the Kikori that are located in Enga, Southern Highlands and Hela, and part of Western Provinces but flow out into the Gulf of Papua. In the Gulf of Papua is the commercial prawn fishery for Papua New Guinea. Prawns are exported for foreign exchange and this industry is heavily dependent on mangrove ecosystems that are the nursery areas for the prawns to be protected.

Therefore, all efforts to protect the Kikori River Basin are a must as all life in the environment and the people are dependent on each other.

LESSON 5A – JUNIOR PRIMARY

Name of Lesson: My Environment Provides for Me.

Objective: By the end of the lesson, students can:

- Demonstrate an understanding of the importance of the environment to their communities.

Key Knowledge:

1. Living things in the environment depend on each other.
2. People's livelihood depends on the environment.

Materials Needed: Notebooks, pens or pencils, markers or colouring pens, pencils and crayons, activity sheets

Preparation: Use posters, information and facts sheets or other resources to teach the children about the importance of their environment and its benefit to their people and communities.

Activity: Story Telling: Begin this activity by allowing 3 or 4 students to tell stories about how they obtain food and other resources from the forest, lake, river or the sea; depending on the type of environment they live in or near. Make a list of these on the black board – *fish from lake, river or sea; timber from the forest or sago from the swamp forest*. Students' responses can be presented on the table like the one below.

TYPE OF ENVIRONMENT	RESOURCES OBTAINED
Lake/River	Fish, eel, crab, shrimp
Sea/Estuary	Fish, prawns, crabs, shrimps
Swamp forest	Sago, grubs
Rainforest	Timber, wild meat, wild berries & fruits

Based on students responses, ask the class to talk about what they think would happen if their forest, lake, river or sea is destroyed. Children's responses can be listed on the board – *there will be no fish or other aquatic protein, no timber for building house or fence, etc. and no food like sago*.

Explain to the class that people are dependent on their environment for their survival. Similarly, living things that live in these environments also depend on each other for their survival.

Evaluation/Homework: Remind the class that people are dependent on their environment. Other living things also depend on each other and their environment for their survival. For homework, students can draw pictures of people getting resources from their environment. For example, someone is fishing in the lake.



LESSON 5B – JUNIOR PRIMARY

Name of Lesson: Protecting and Conserving my Environment.

Objective: By the end of the lesson, students can:

- Demonstrate an understanding of the importance of protecting and conserving their environment.

Key Knowledge:

1. Awareness on over harvesting of plants and animals.
2. Protecting the environment and its inhabitants for future generations is very important for all communities.

Materials Needed: Notebooks, pens or pencils, markers or colouring pens, pencils and crayons, used cardboards and posters, butcher paper, songs or poems

Preparation: This activity may take up two lessons. Ensure that you use posters, information and facts sheets or other resources to teach the children about the importance of these plants, animals and their habitats.

Activity: School Awareness In this activity, students will work in groups to discuss how they will create awareness on the importance of their environment. Explain the activity to the class ensuring that your instructions are very clear as to what students are expected to do. Ask them to talk about the importance of plants and animals in their environment and make note of these points on the chalkboard. You must guide the children to decide on the method they will use to carry out their awareness at the school. They can compose a song, poem or short play about plants and animals in a particular habitat.

Note: Arrange with the teachers for students to carry out this performance during school assembly and invite parents to observe this activity.

Divide the class into manageable groups of five to six. Each group will discuss and choose the method they are comfortable with. Allow students to discuss their ideas such as importance of habitats and their inhabitants, importance of the dependence of the communities on the environment and uses of plants and animals for food, shelter, etc.

Distribute materials to each group according to what they have decided to do. Appoint a group leader to be in charge of the group. Children can present their work during assembly once they have finished.

Evaluation/Homework: Remind the class that their environment is very important. It provides everything they need to survive in their communities. For homework, students can complete their awareness task.

Assessment Activity: You can assess this activity by preparing criteria to assess their participation and confidence in working as a group.



LESSON 6A – SENIOR PRIMARY

Name of Lesson: Dependence on my Environment.

Objective: By the end of this lesson, students can:

- Demonstrate an understanding of the importance of the environment for cultural and ecological reasons.

Key Knowledge:

1. Cultural and ecological diversity of the Kikori River Basin
2. Survival of people and their livelihood depends on the environment.

Materials Needed: Notebooks, pens or pencils, questionnaires, information brochures or posters on Kikori River Basin

Preparation: These activities may take up to two lessons. Help your students to identify the kind of environment they live in e.g. coral reef, freshwater lake, rainforest, swamp, mangrove, river, etc. Then carry out the activities. Ensure that you use a variety of resources such as posters, information and facts sheets to teach the importance of these habitats to their people and communities.

Activity: Guest Talk In this activity, the class will listen to a guest speaker and ask questions. Explain the activity to the class ensuring that your instructions are very clear as to what is expected in that lesson. Begin by asking students to talk about the importance of the environment to the people and surrounding communities and make note of these points on the chalkboard. You must help your students to freely express their thoughts and opinions about the benefits of their environment to the people and their communities.

Invite a specialist on environments as a guest speaker. This person can be from the government department such as “Conservation and Environment Protection Authority” or a non-government organisation such as WWF. S/he can talk to the class about the importance of their environment and the benefits it gives to their communities. Before the guest talk, discuss and write down questions to ask the specialist. Some questions to think about can be centred on the following:

- (i) Importance of different types of environments to people.
- (ii) Renewable and non-renewable resources.
- (iii) Protected areas in the immediate environment as well as in Papua New Guinea.
- (iv) Types of plants and animals in different habitats in Papua New Guinea.

Students can write a brief report on what the guest speaker had talked about. This can be assessed using criteria.

Evaluation/Homework: Ask the class to state few important things they learnt from this talk. Remind the class that their environment is very important. It provides everything they need to survive in their communities. For homework, students can find out about what actions they can take to protect their environment.

LESSON 6B – SENIOR PRIMARY

Name of Lesson: Taking Actions for my Environment.

Objective: By the end of this lesson, students can:

- Take actions to protect the environment.

Key Knowledge:

1. Opportunities for beneficial income generating activities for communities.
2. Protecting the environment and its inhabitants for future generations is very important for all communities.

Materials Needed: Notebooks, pens or pencils, questionnaires, information brochures or posters on Kikori River Basin.

Preparation: This activity may take up two lessons. It requires you to prepare your students to carry out a survey of a nearby coastal or inland community. They are to find out what people think about the importance of their resources as a livelihood, how they have used the plants and animals that live there and if they are protecting and conserving them to sustain their lives. Assist your students to design and write a survey questionnaire which should have at least three (3) key questions.

Activity: A Survey In this activity, your students will carry out a survey about people's opinions on:

- (i) The effects of the loss of resources in their environments, and
- (ii) Types of sustainable income generating activities that will benefit the communities.

To do this, brainstorm ideas in order to help guide your students. Divide the class into groups of five or six. Each group will be responsible for a particular part of the village or community to conduct three to four home visits to complete the questionnaire. Each group will then summarise their findings and report back to the class. During reporting, all groups will write their responses for the class to discuss. Write up a summary of the responses as they may be similar.

Evaluation/Homework: Ask each group to write up one suggestion on what people and their communities can do to protect their environments. These can be summarised on a chart paper and displayed on the classroom wall. For homework, groups can design posters to put up around the school and community notice boards.

Assessment activity: Create your own criteria to assess each group's ability to create their own questionnaire, carry out the survey and summarise and present their reports.

UNIT 2: OUR NATURAL ENVIRONMENT



Photo: Lake Kutubu@Kyaro/WWF/2019

2.1 Introduction

The earth is a physical system consisting of bedrock that form large land masses, mountain ranges, valleys and islands that are above the waters. We call these continents and islands.

The major continents are Europe, Africa, Asia and the Americas. Australia, New Zealand, Greenland, Caribbean Islands, New Guinea and small islands of the South Pacific such as Tonga, Fiji, New Caledonia and Cook Islands are islands or land above the waters. Land that is completely covered under oceans and seas is called the seabed. The seas and oceans cover the seabed to separate the continents and islands.

In this unit, you will teach your students about the importance of life on earth. Students must understand how all living organisms including human beings have survived on this planet by depending on each other for their survival. This knowledge will help your students to understand and learn more about their own environment, and to appreciate the protection of their resources for their benefit as well as the future generations.

Today we have different countries such as Germany, Italy and Switzerland in Europe; Kenya and Uganda in Africa; India and China in Asia; Canada, United States of America, and Chile in the Americas; and the South Pacific Islands such as Solomon Islands and Vanuatu.



Fig. 6 Google map showing PNG & Indonesia ocean floor/seabed

Well known mountain ranges include the Himalayas, the Andes, the Swiss Alps and others. PNG has Kubor Ranges in the Simbu Province, Sarawaged Ranges in the Morobe Province, Owen Stanley Ranges in the Central, Oro and Milne Bay Provinces and the Bismarck Ranges in the Madang Province.



Fig. 7 Photo of Owen Stanley Range in Central and Oro Provinces¹

¹ Source: Wikipedia (www.wikipedia.com)

Large rivers include the Nile in Egypt and Africa, the Danube in Europe and the Amazon in South America, the Fly and the Sepik Rivers in Western and East Sepik Provinces.

Major oceans and seas separate continents and islands. The Atlantic Ocean separates Europe and Africa from the Americas. In the south, the Indian Ocean separates Africa and India from South East Asia and Australia. On our doorstep the Pacific Ocean separates Asia, Russia, Australia and New Zealand and the South Pacific countries from North and South America.

In PNG, the Bismarck Sea separates the mainland from Manus, New Ireland and New Britain islands. The Solomon Sea, separates the Solomon Islands from Bougainville, south coast New Britain, Morobe, Oro and Milne Bay Provinces. The Coral Sea separates PNG from Australia.

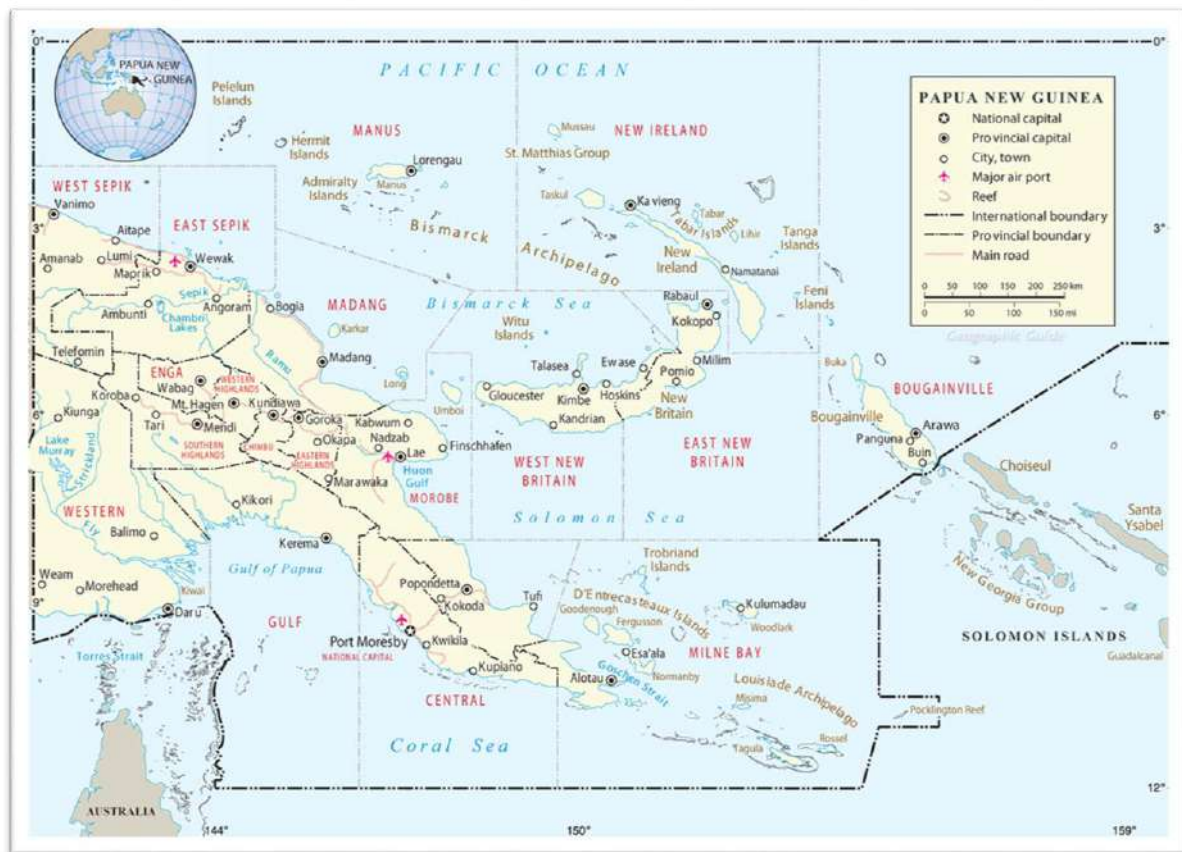


Fig. 8 Map of PNG showing main seascape and landscape in PNG

2.2 Climatic Zones

Climate and weather are closely related words. Weather means temperature, air pressure, humidity, precipitation (rain/snow), sunshine/warm/hot, cloudiness/fog, thunder, pressure, ocean temperatures and winds. The weather changes every minute, hour or day and they are measured and recorded at the weather stations to produce weather patterns after period of some time. The average weather pattern is the climate. Climate is weather pattern generated after many years of collecting weather information.

Based on different weather patterns experienced in many places around the world, the climatic zones have been identified and grouped accordingly. The main climatic zones are the Polar Region, Temperate Zone, the Sub-Tropic Zone and the Tropical Zone. These zones are classified based on the amount of sunlight received and the variation in the weather patterns. Tropical regions receive full sunlight and high temperatures; temperate regions receive full sunlight and mixture of high and freezing temperatures. The Polar Regions receive no sunlight during six months of the year and experience freezing temperatures all year round.

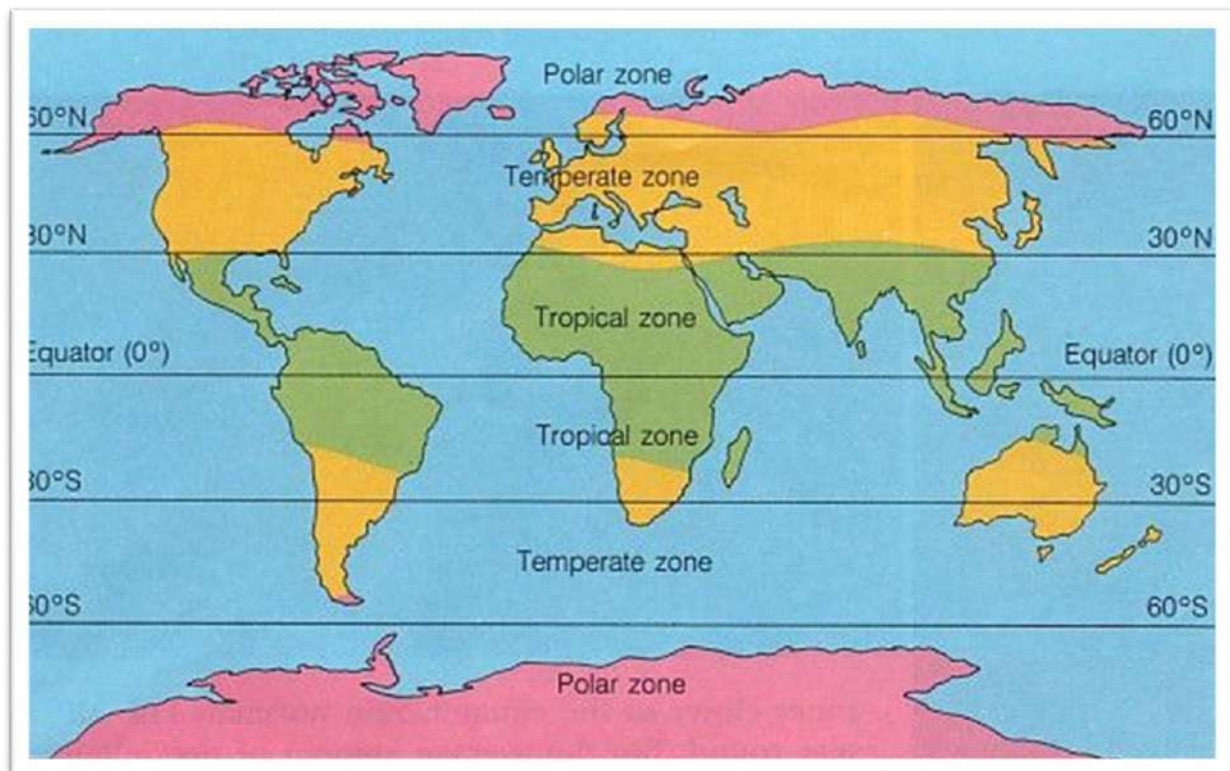


Fig. 9 Map showing the different climatic zones of the earth²


2.3 People and Culture

The People of the World

There are different races of people in the world. Caucasians are white skinned races largely from Europe, the Americas, Australia and New Zealand. Mongoloid races are Asians from India, China, Japan, Malaysia and Indonesia and Black skinned people or Negroids are from Africa and most of us in the South Pacific islands. The human race is part of the natural environment.

People of different races live in their own countries in villages, towns and cities. All human beings are part of the natural environment. Built up areas, meaning the construction of villages, towns and cities involve the removal of trees and vegetation. Roads and bridges connecting

² Pinterest.com



different areas need the earth and ridges to be removed and so as wharves connecting different seaports. Human beings change the environment by constructing houses, towns and cities to live in. These form part of the built environment within our natural environment.

The Cultures of the World

Humans are set apart from other members of the animal kingdom because of our ability to develop customs and traditions which form our cultures. Cultures vary across the world, some of which are very traditional like in Papua New Guinea while others are more modernised like in the United Kingdom. Many differences exist in the world cultures but most commonly you can recognise these in people's food practices, clothes, houses they construct and gardening or farming practices. One relevant point to note is that all cultures are influenced by our environments and geographical locations.

When you look at the Kikori River Basin, you will find that it is also culturally diverse because it is located within five provinces of PNG - Southern Highlands, Hela, Enga, Gulf and Western. The traditional cultures of the basin encompass the highland and coastal communities and are also determined by the type of environments which range from lowland rainforest, to savannah grasslands, and wetlands including the coastal swamps and marshlands.



TOPIC 1: THE NATURAL ENVIRONMENT

All the land, mountains, valleys, rivers, forests, animals such as birds, crocodiles, fish and frogs; beaches, mangroves, oceans, coral reefs, freshwater lakes and rivers are all parts of our natural environment. The sky, clouds, moon, the stars, galaxies and planets; winds such as the Northwest and the South-easterly winds, the air that we breathe, the wet and dry seasons; winter, spring, summer and autumn are also part of our natural environment.

There are some very important natural systems that maintain functioning of natural environment. These natural systems are the *Water Cycle*, the *Carbon Cycle*, the *Nitrogen Cycle* and the *Ecosystems*.

The Water Cycle

The Water cycle refers to the cycling and recycling of water into its various forms for use by all living systems. Land masses, the trees, rivers and lakes and clouds are the systems that transfer and transform water into its various forms. Rivers and lake water is in liquid form. When the Sun heats up the surface of rivers, streams, lakes and oceans, the water vapour or steam is carried into the atmosphere where it condenses and fall back to earth as rain.

The water is present on the land surfaces on the physical land, grasses, trees, buildings, mountains, and rocks. The water present in these bodies is in the form of water vapours, pools, pebbles and moisture. They are deposited by rain. These water bodies evaporate during daytimes and rise up into the atmosphere as water vapour and form clouds.

Similarly, plants take up liquid water in their roots and expel additional water as vapour through their leaves. Water vapour (gaseous state) that releases into the atmosphere is brought by usual winds and the rise and fall of heat over ridges and mountains to form mists and clouds. This water vapour then condenses and falls as rain.

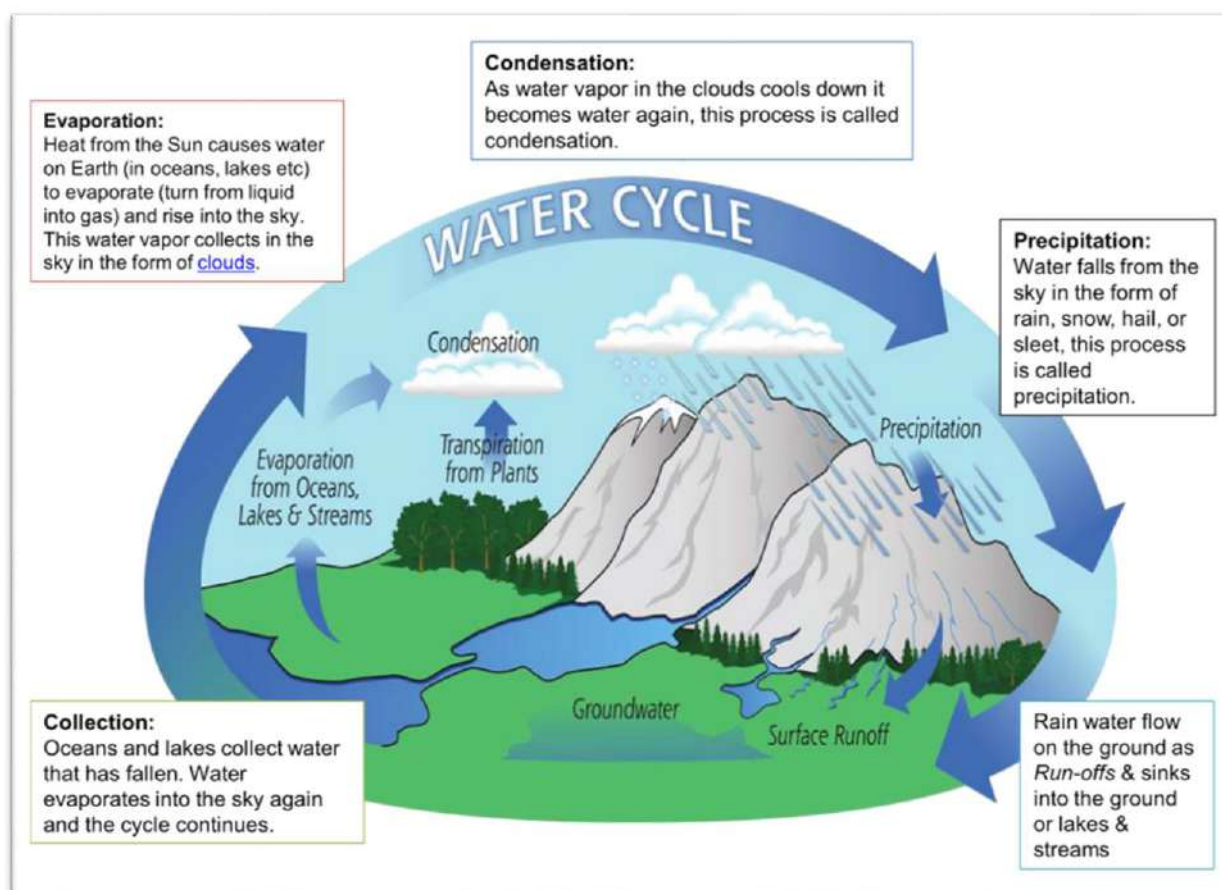


Fig. 10 The Water Cycle³

The Carbon Cycle

Carbon is an element found in many different forms and locations within our Earth and atmosphere. It is found abundantly in living organisms. We would not even exist without this element. The key molecules (particles) that make up our bodies, such as proteins, carbohydrates, and DNA contain carbon as a major component.

Carbon is also found abundantly in our atmosphere in the form of carbon dioxide gas, or CO₂. Carbon is also trapped within the Earth in the form of fossil fuels.

The carbon cycle is nature's way of reusing carbon atoms in different ways and in varying places. It is the process in which carbon travels from the atmosphere into organisms and the Earth and then back into the atmosphere. It is important to remember that our Earth and its atmosphere as a whole is a closed environment. The matter that exists now is all that we will ever have. Think of water, as an example, water cycles through the Earth and atmosphere constantly. Water is never created or destroyed, just recycled.

Similarly, we have a fixed amount of carbon on Earth and in the atmosphere with nothing escaping or entering our world. That means that all of the carbon we have on Earth and in the atmosphere is the same amount we have always had. And so, when new organisms are being

³ Source: <https://blogs.glowscotland.org.uk/re/primary5bps/2018/10/05/p5s-the-water-cycle/>

formed, carbon is needed to form those key compounds such as protein and DNA in living cells.

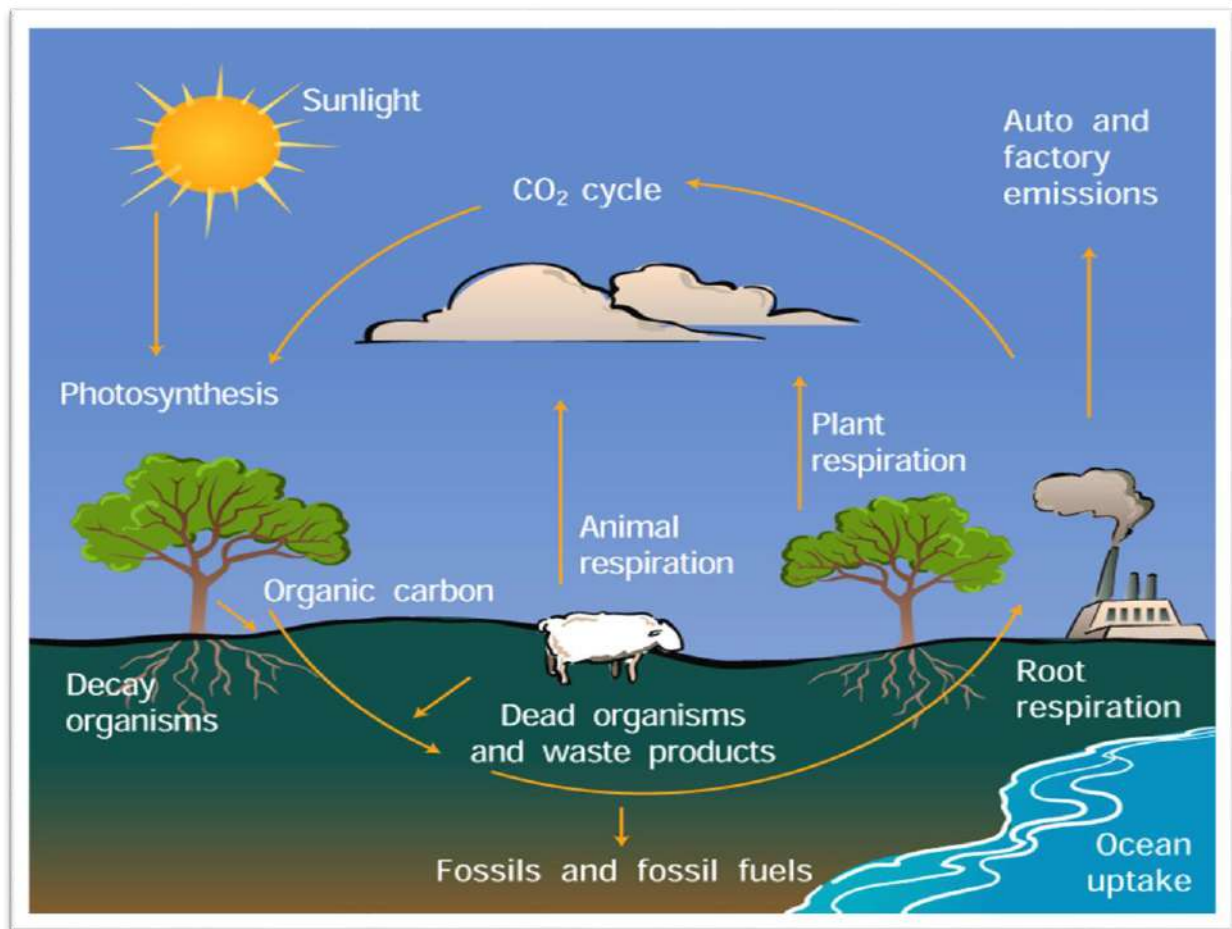


Fig. 11 The Carbon Cycle⁴

The Photosynthesis Process⁵

Plants need carbon dioxide (CO_2) to make their food (simple sugar or carbohydrate) during the photosynthesis process. CO_2 comes from many sources including respiration from animals and humans; burning fossil fuels in vehicles, factories and homes; bushfires, and volcanoes etc. Plants utilize this CO_2 with energy from the sunlight and water to produce their food for growth. In return they produce Oxygen (O_2) as their waste product which we humans and other animals depend for survival. Therefore, forest acts as Earth's purifiers by soaking up large amount of CO_2 from the atmosphere.

⁴Source: <https://scied.ucar.edu/carbon-cycle>

⁵ https://upload.wikimedia.org/wikipedia/commons/f/fd/Photosynthesis_equation.svg

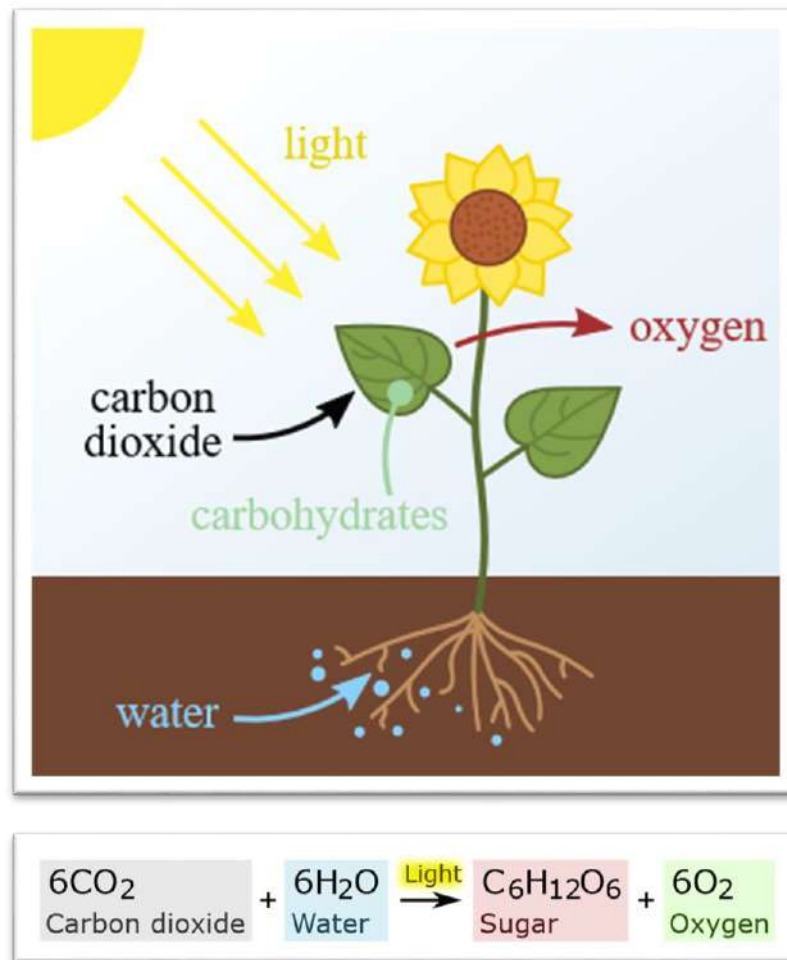


Diagram 1 Illustration of the Photosynthesis process in green plants with scientific equation

The Nitrogen Cycle

Nitrogen is the most plentiful element in our atmosphere and the fifth most plentiful in the universe. All living things need nitrogen to build proteins and to use in their cells. Nitrogen moves from the atmosphere into living organisms and then back into the atmosphere through the nitrogen cycle.

Plants and animals could not live without nitrogen. It is an important part of many cells and processes such as amino acids, proteins, and even our DNA. It is also needed to make chlorophyll in plants, which plants use in photosynthesis process to make their food and energy.

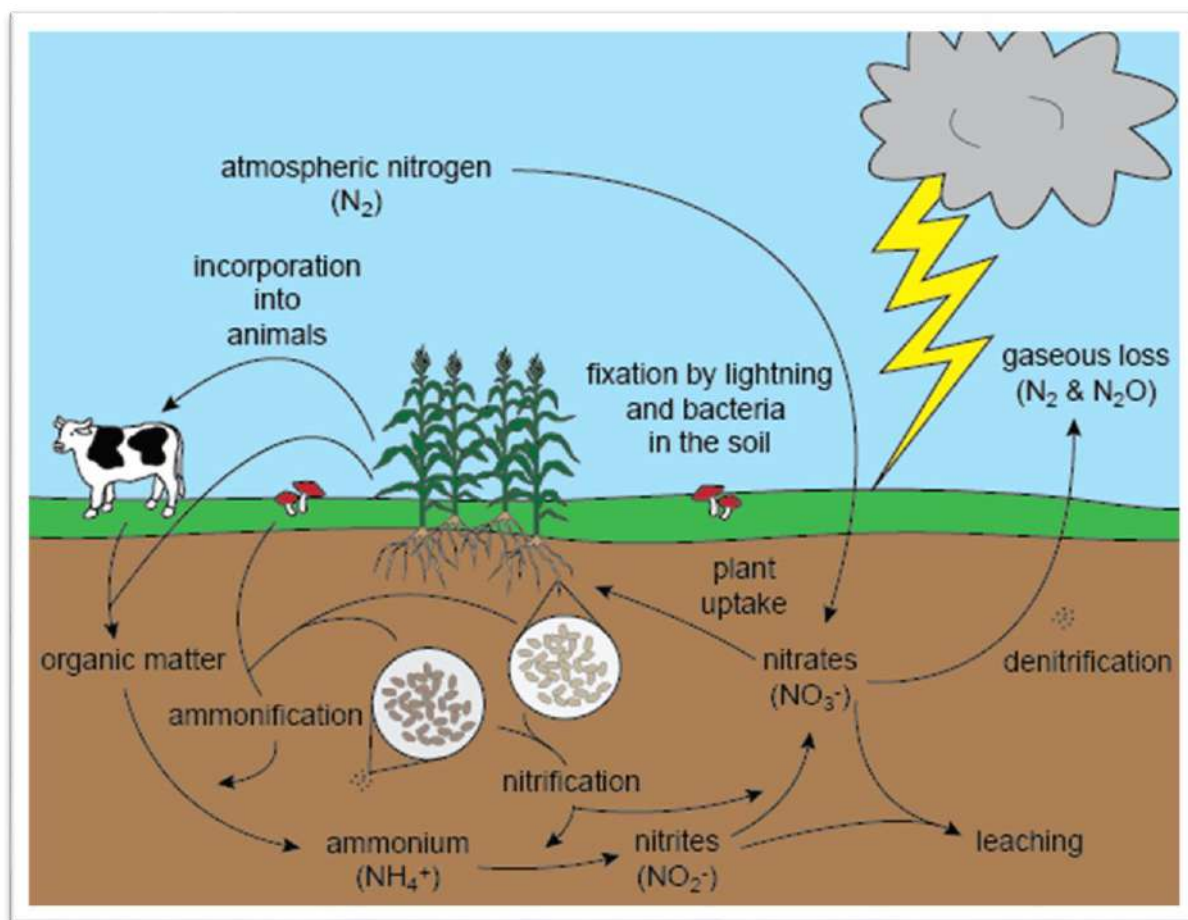


Fig.12 The Nutrient Cycle⁶

The Ecosystem

An ecosystem includes all living things (plants, animals and organisms) in a given area, interacting with each other, and also with their non-living environments (weather, earth, Sun, soil, climate and atmosphere). Ecosystems are the foundations of the biosphere and they determine the health of the entire earth system.

Ecosystem simply means 'ecological systems'.

Ecology is the study of ecosystems.

In an ecosystem, each organism has its own role to play. Imagine a small puddle at the back of your home or a small creek or stream near your house in the village. In it, you may find all sorts of living things, from micro-organisms to insects and plants. These may depend on non-living things like water, stones, pebbles, sunlight, turbulence in the puddle or creek and stream, temperature, atmospheric pressure and even nutrients in the water for life.

⁶ Source: <https://scied.ucar.edu/nitrogen-cycle>

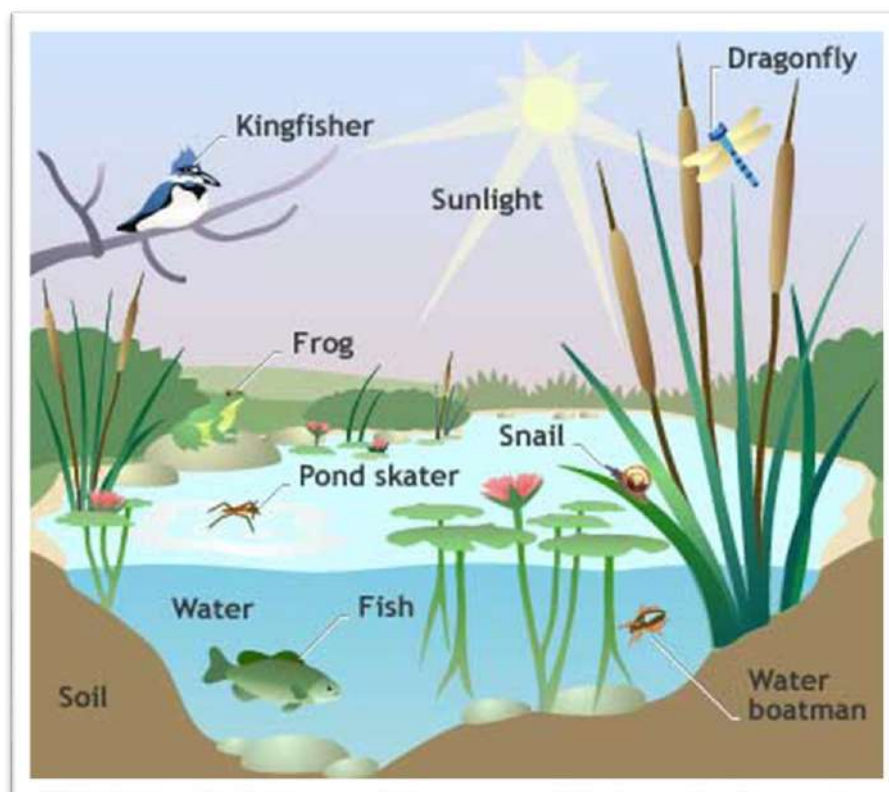


Fig. 13 Ecosystem diagram⁷

This very complex, wonderful interaction of living things and their environment is the foundation of energy flow and recycle of carbon and nitrogen.

Anytime a 'stranger' (new living thing) or external factor (e.g. rise in temperature) is introduced to an ecosystem, it can be disastrous to that ecosystem. This is because the new organism (or factor) can change the natural balance of the interaction and can harm or destroy the ecosystem.

There are two large or main types of ecosystems in our environment: the *terrestrial* ecosystem and the *aquatic* ecosystem. The terrestrial ecosystems are those ecosystems exist on the land. While the aquatic ecosystems are those that are found in our river systems, lakes, swamps, and oceans. These two ecosystems are very large because they also contain other ecosystems within them. All living organisms and the non-living substances exist in these ecosystems. These two main ecosystems will be described further in topics 2 and 3. *Try to identify the type of ecosystem in your own environment, understand and appreciate why these living organisms are important in your environment.*

All living things in these ecosystems depend on each other for survival. In order for us to understand how living things including ourselves depend on each other, scientists have helped us by describing these activities through simple feeding relationship processes called 'food

⁷ Source: slideshare.net

chains, food webs and food pyramids. You will learn more about these processes further in this topic.

Let us look at the two important processes, the food chain and the food web that enables all living things to contain life in their own environment.

What are a food chain and a food web?

Living things need to feed to get energy in order to grow. They need to move and reproduce. But what do these living things feed on? Smaller insects feed on green plants, and bigger animals feed on smaller ones and so on.

This feeding relationship in an ecosystem is called a **food chain**. Food chains are usually in a sequence, with an arrow used to show the flow of energy. For example:

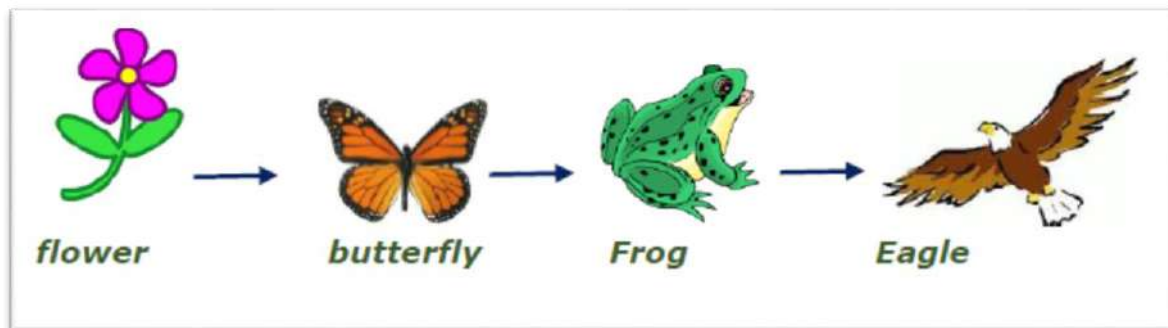


Diagram 2 Illustration of the simple food chain

A food chain is not the same as a food web. A food web is a network of many food chains and is more complex. For example, in the food web illustration below, you can pick out many food chains.

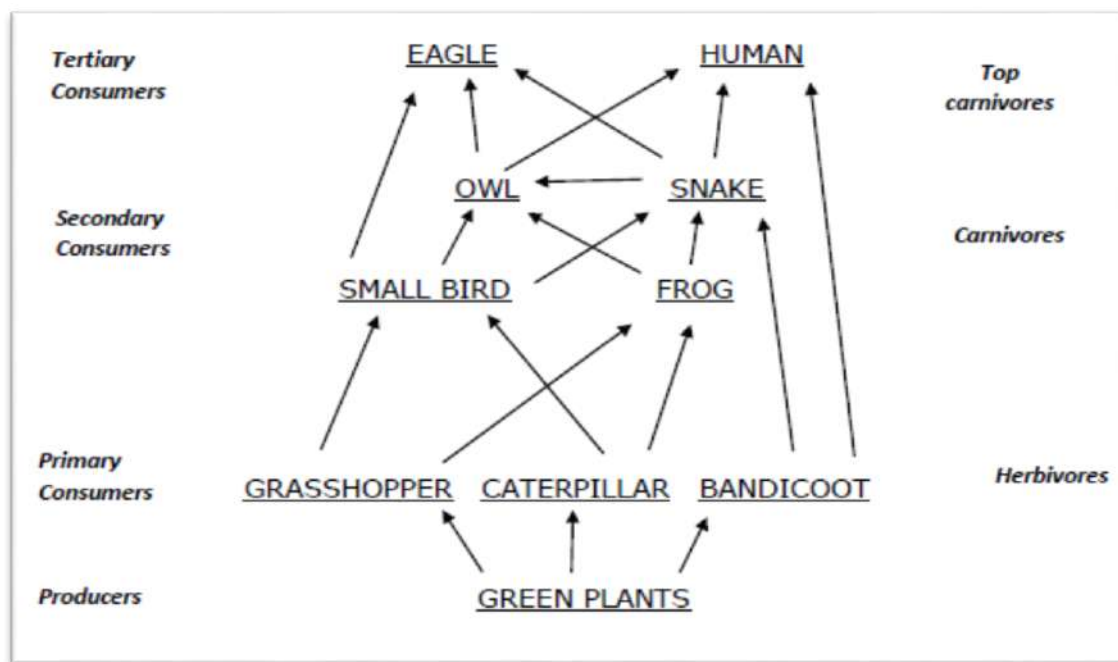


Diagram 3 Illustration of different food chains combined to form a food web in an ecosystem

Energy Transfer

Energy is transferred along food chains from one level to the next. Some of the energy is used up in growth, reproduction repair, movement and other ways, and not made available to the next level. Shorter food chains retain more energy than longer chains.

The *Sun* is the source of all the energy in food chains. Green plants, usually the first level of any food chain, absorb some of the Sun's light energy to make their own food by photosynthesis. Green plants are therefore known as '*Producers*' in a food chain.

The second level of the food chain is called the *Primary Consumers*. They consume the green plants. Animals in this group are usually called *herbivores*. Examples include insects, bandicoots, wallabies, kangaroos, caterpillars and cows.

The third in the chain are *Secondary Consumers*. These usually feed on the primary consumers and other animal matter. They are commonly called *carnivores* and examples include hawks, eagles and snakes.

The fourth level is called *Tertiary Consumers*. These are animals that eat secondary consumers and are often called top carnivores. Examples include crocodiles and New Guinea Harpy Eagle.

LESSON 7A – JUNIOR PRIMARY

Name of Lesson: The Natural Systems.

Objective: By the end of this lesson, students can:

- Identify natural systems that support life.
- Recognise the importance of food chain and food web.

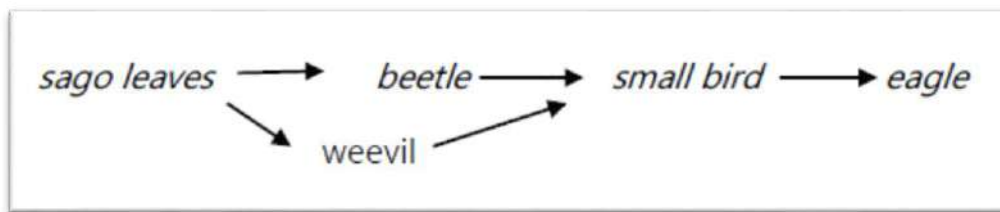
Key Knowledge:

1. The natural environment is made of different living and nonliving things.
2. There are systems in the natural environment that support life.

Materials Needed: Pictures and posters of natural environment, food chain and food web.

Preparation: Ensure you have posters, information and facts sheets or other resources to teach the children about food chain and food web.

Activity: Making Connections: Begin this activity by asking the students to list the things that their environment provides for them. Write this list on the blackboard (e.g. food, water, air, timber, shelter for wild animals, etc.). Choose one of these services that the environment provides such as food. Talk about what foods people get from the environment (e.g. sago) and list this on the board. Then show the relationship between sago and other animals by asking about who feeds on the sago palm leaves (e.g. sago beetle) and who feeds on the beetle, and so on. In this way, you can help the children to build a food chain or food web. *This could also be illustrated through the use of pictures or cards, labels and strings.* For example:



Students can work in groups to draw pictures of animals feeding on each other to develop food chains or a food web.

Evaluation/Homework: Remind the class that the natural environments have systems to support life. These systems show that all living things are dependent on each other for their survival. For homework, ask students to find out how rain is made.

LESSON 7B – JUNIOR PRIMARY

Name of Lesson: The Natural Systems – Water Cycle.

Objective: By the end of this lesson, students can:

- Recognise the importance of natural systems like water cycle.
- Briefly describe how rain is made.

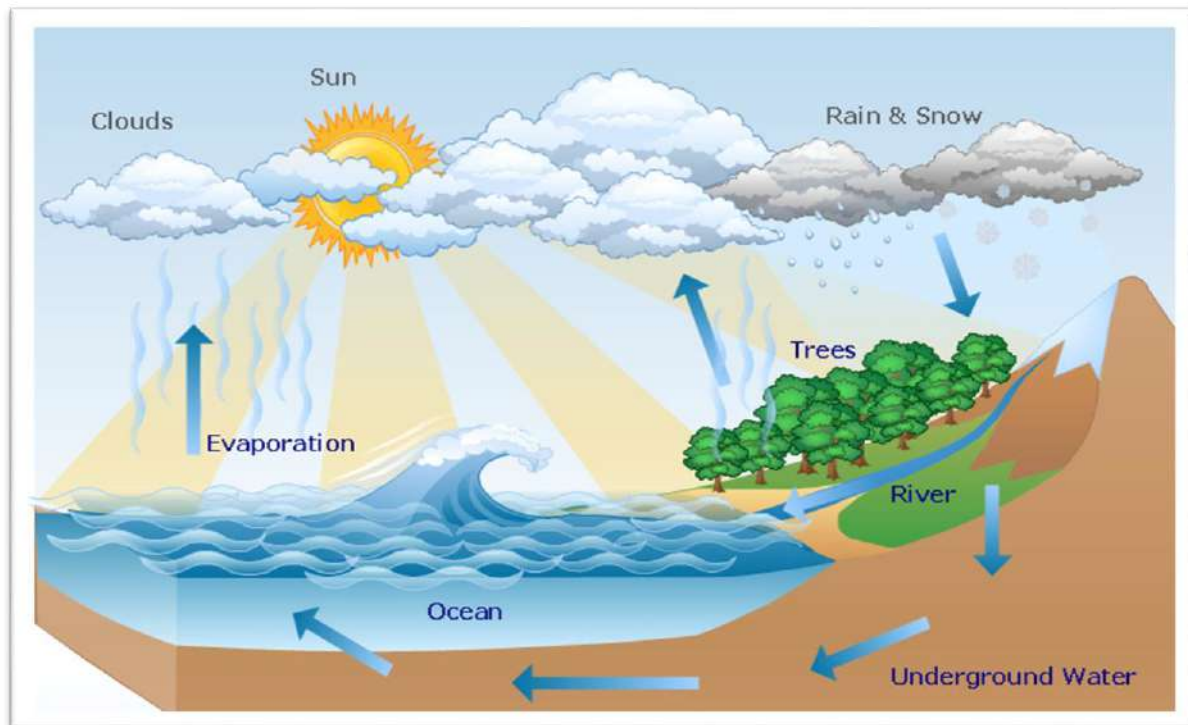
Key Knowledge:

1. All living things need water to survive.
2. Water goes around through the earth and atmosphere all the time.

Materials Needed: Pictures and posters of natural environment, water cycle.

Preparation: Ensure you have posters, information and facts sheets or other resources to teach the children about water cycle.

Activity: Discussion- Have the class brainstorm on how rain is made. Students' responses can be listed on the blackboard. (*Accept any answer students give as it will depend on what they know from talking to their parents and elders*). Use the diagram of the water cycle on Figure 10 page 44 or the simplified diagram below to discuss how rain is formed i.e. water vapour or steam rises when the Sun heats up the land and water such as in the sea, rivers, lakes or puddles. As it reaches the atmosphere, it cools down and falls as rain.



Evaluation/Homework: Remind the class that the natural environments have water cycle that helps to clean or make the water fit for all living things to use. For homework, students can draw their own pictures of water cycle and colour it.

LESSON 8A – SENIOR PRIMARY

Name of Lesson: Feeding in the Natural Environments.

Objective: By the end of this lesson, students can:

- Recognise animals found in the grassland and forest environments.
- Make a list of foods eaten by forest animals.
- Make a list of foods eaten by grassland animals.

Key Knowledge:

1. Animals like to live in different environments.
2. Animals eat both plants and other animals.
3. Some animals eat only plants. Others eat only animal flesh.

Materials Needed: Pictures and posters of grassland and forest environment including plants and animals.

Preparation: Prepare pictures of animals from grassland and forest. Divide students into small groups and distribute one picture to a group. Have a recorder to note their discussion and another to present it.

Activity: What do I eat? - Begin the lesson by talking about the different kinds of environment that students have visited, live near or grew up in. Ask them to describe the plants and animals they have encountered. Inform the class that they are going to study pictures of different animals from the grassland and forest environments. They will then use these pictures to suggest the kind of food these animals eat. Refer to *Activity Sheet 2.1* for the pictures. They can prepare their summary as shown below:

ANIMAL	WHAT I EAT	WHERE I LIVE
Frog	Butterflies, moths, flies	Lakes, rivers, forest
Snake	Rats. Mouse, baby birds	Forests, grasslands
Bird of Paradise	Fruits, seeds, insects,	Forests
Tree kangaroo	Leaves, shoots, fruits	Forests

Ask students to write up a food chain using one of the animals. For example:





Nectar → *Butterfly* → *Frog* → *Eagle*

Explain that a food chain is a chain showing flow of energy from one food source to another.

Evaluation/Homework: Remind the students that animals in the forest and grasslands feed on other animals or plants and are eaten by other animals. For homework, students can draw food chains for each of the animals on the table.

Activity Sheet 2.1 ~ What do I Eat?

Study the animal pictures in Column 1. In Column 2, make a list of possible foods that this animal will feed on. In Column 3, say something about where it lives.

ANIMAL	WHAT I EAT	WHERE I LIVE
 <p>Frog</p>		
 <p>Snake</p>		
 <p>Bird of Paradise</p>		
 <p>Tree kangaroo</p>		

LESSON 8B – SENIOR PRIMARY

Name of Lesson: The Food web.

Objective: By the end of this lesson, students can:

- Describe a grassland food web.
- Construct a simple rainforest food web.

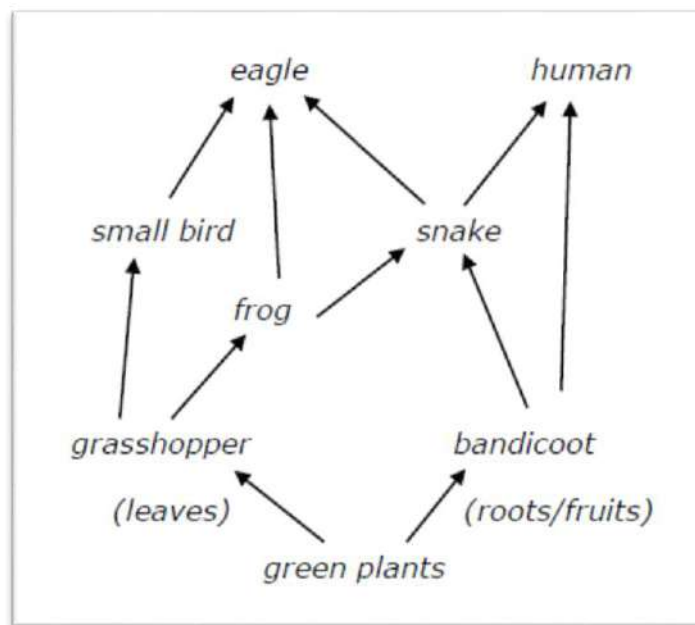
Key Knowledge:

1. Food chains show a linear feeding relationship.
2. Food webs show complex feeding relationship.
3. Some animals are specialised feeders while others are mixed feeders.

Materials Needed: Pictures and posters of grassland and forest animals and plants, a 2m to 3m long string, medium sized name cards, strings to attach to name cards and sticky tape.

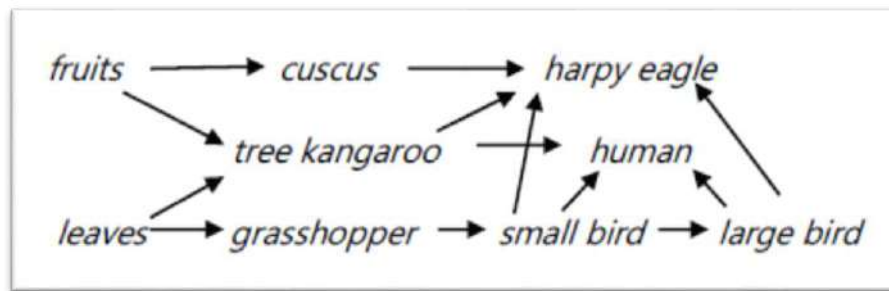
Preparation: Write the names of rainforest plants and animals on name cards with two punched holes and a string placed in this. If strings are not easily accessible, sticky tape can be used instead.

Activity: Food web Game – Begin the lesson by asking the class to name some common grassland animals. Ask the class to briefly name the different foods these animals eat. Use these to write up a sample food web on the blackboard. For example:



For the food web game, distribute the name cards to the class. These must be taped or hung around their necks. Have the class stand in a large circle. Tell the class that all energy begins with the Sun. This energy is directly absorbed (taken in) by the plants to make their food during photosynthesis process. This is converted to food energy which is stored in the plant. When the animal feeds on this, they then acquire the energy which continues using this process.

Begin the game by giving the end of the string to a person wearing the tag with a plant name. For example, fruits. Then ask them to state who eats this plant food. Example, cuscus. Link the plant to the animal by the string. Then continue to another animal that feeds on this animal that eats the plant. (*Note: One animal can eat more than one food. Therefore, one animal can hold more than one end of the string that connects it to these different foods*). For example, harpy eagle eats the cuscus. Continue until all the students in the circle with the name tags have been linked to each other by the string that they are holding. This enables the class to visually see the interconnectedness that exists in nature. For example:



After constructing the food web, tell them that what if a logging company comes in and cuts the trees and plants. What do you think will happen? *Students can give their own answers including for example, all the plants will be the first to be affected.* Tell the students wearing plant name tags to let go of the string. Ask animals to say what they are feeling now. *e.g. The string is loose around the hand.* Tell those wearing animal name tags to also let go of the string. Ask them about what they can see. *Students can give their own interpretation such as the food web is destroyed.* Emphasise that this is what happens in the real world. If one part of the environment is affected, it harms other parts as well.

Evaluation/Homework: Remind students that everything in the environment is connected. When one part of the environment is destroyed, it affects the others. For homework, ask students to find out about the importance of insects like the butterfly. You can also choose to give a copy of the story about the life cycle of the butterfly in Appendix D on page 208. *How do destroying plants and flowers affect butterflies? How will this affect the food web?* Students can write a short essay on this.

Assessment Activity: You can develop your own assessment criteria to assess this activity.



TOPIC 2: TERRESTRIAL ECOSYSTEMS

What is a Terrestrial Ecosystem?

A terrestrial ecosystem refers to the inter-relationships between plants and animals that live on land with their environment. The word terrestrial means *land dwelling*. Ecosystem comes from the words ecology and system.

Ecology is the study of the inter-relationships between plants and animals and their physical environment. *System* means a group of independent but interrelated elements comprising a unified whole. In other words, these living systems form independent groups that are independent of each other, self-regulating, self-sustaining but interrelated with each other to sustain life on earth.

Across the whole earth, the Water Cycle, Carbon Cycle and Nitrogen Cycle, the winds and seasons that are temperature dependent form part of the physical support systems to plants and animals to live and reproduce.

There are five major terrestrial ecosystems:

- Desert Ecosystems.
- Forest Ecosystems.
- Taiga (or coniferous forests) Ecosystems.
- Grassland Ecosystems.
- Tundra Ecosystems.

We will look at two of the above ecosystems and these are: the *forest* and the *grassland* ecosystems. Our natural environment in Papua New Guinea is mainly made up of the two ecosystems. These two ecosystems also have other ecosystems within them.

As you continue to read and learn about the ecosystems, try to identify the type of ecosystem in your natural environment. You may have both ecosystems in your natural environment that also contain other ecosystems. Your students must learn to know, understand and identify the types of ecosystems in their own environments.

1. The Forest Ecosystem

Forests are considered as one of the top five (5) natural resources on earth. We will look at how wonderful our forests are to us, and why we should immediately stop its' destruction. There is more to forests than just a massive collection of trees. It is a natural, complex ecosystem, made up of a wide variety of trees that support a massive range of life forms. Apart from trees, forests also include the soils that support the trees, the water bodies that run through them and even the atmosphere (air) around them.

Forests come in many sizes and forms. For example, the piece of land with huge trees and many animals, birds and water bodies running through it in a part of your own environment can be called a forest.

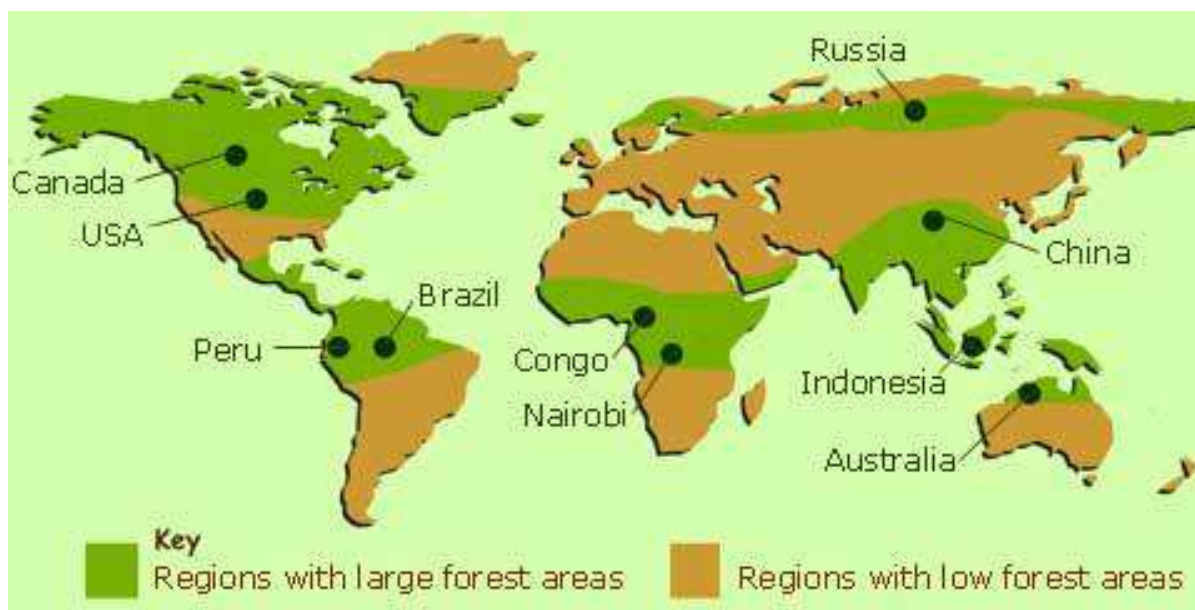


Fig 14 Map of forest distribution in the world⁸

It is estimated that two-thirds of the world's forest are currently distributed among 10 countries:

Forests are very important for life on earth. This is because it serves as an ecosystem, and sustains life for millions of animals and birds that live in the rivers and streams running through these forests. It also does a lot of good to the atmosphere in climate control, as well as supplying oxygen for human sustenance.

Many different types of plants and animals live in the different parts of the forest. These parts of the forest are called '*the layers of the forest*'. The diagram below shows the different layers of the forest. There are four basic structures (layers) of a typical forest. See the differences in the way the forest is naturally organised.

The Emergent Layer (A) - This layer is very sunny because it is the very top and only the tallest trees reach this level. It is also known as the over story. Animals found in this layer include birds, butterflies, bats, snakes and bugs.

The Canopy Layer (B) - This is the thickest layer and much of the rain is stopped by the thick foliage. Most trees in the forest grow to this height. There are plants that grow in the canopy layer whose roots don't reach the ground. These are called air plants, for example, orchids and epiphytes. Animals found in this layer include birds, tree kangaroos, cuscus, frogs, lizards, snakes and many insects.

The Understory (C) - This layer has many vines, dense vegetation but not much sunlight as it is all blocked by the canopy. Plants show stunt growth and remain until forest gaps open up

⁸ Source: IUCN, International Union for Conservation of Nature

through, for example, tree falls, landslips, logging and gardening. Then they start to grow and reach the canopy layer. Animals found in this layer include birds, butterflies, frogs and snakes.

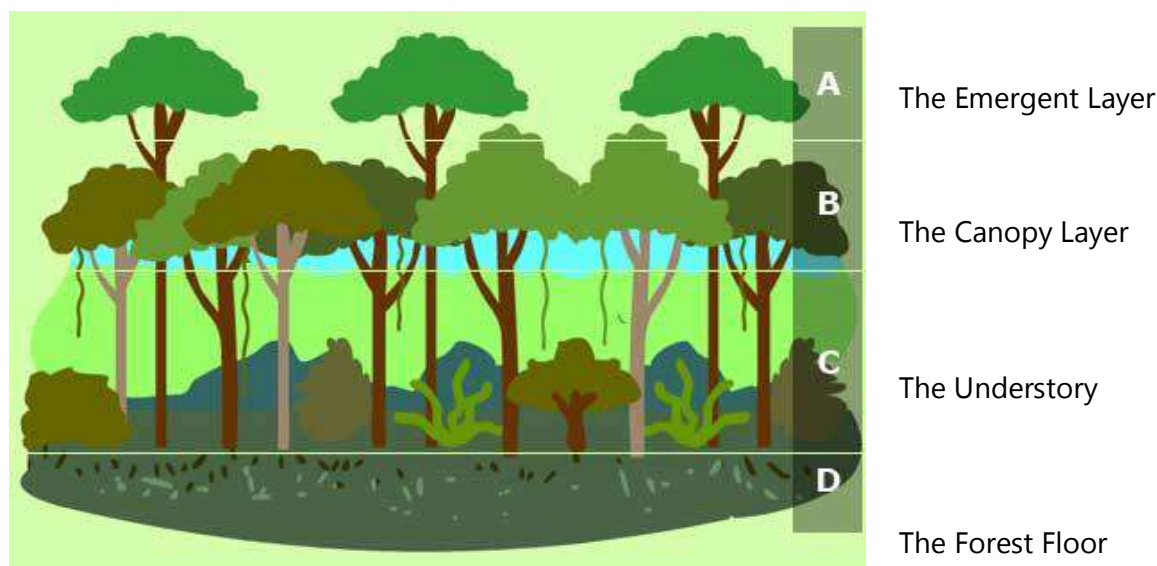


Fig 16 Different layers of the forest

The Forest Floor (D) - This layer is dark, damp and full of many dead leaves, twigs and dead plants. It is usually clear of vegetation, with little or no winds and rains reaching there. The forest floor is dark due to the trees above stopping the sunlight from entering the forest. It is estimated that only 2% of the sunlight actually reaches the floor. Animals found in this layer include jaguars in South America, gorillas, leopards in Africa, tapirs, tigers and elephants in Asia, wild pigs, bandicoots and wallabies in Papua New Guinea. There are lots of foliage insects as well as forest floor and ground insects.

Many species in the rainforest work together. These species often have a long term relationship where they live together. Often such relationship can be either harmful or helpful to one of them. For example, some plants are homes for ants, and the ants protect the plant leaves from being eaten by other insects.

Let us now look at the types and importance of forests. Further in this book, you will learn about the problem of deforestation and its' effects and how these activities have affected all living organisms including us, the people. Your main focus is your immediate environment. Generate discussions on your own environment as students are very familiar with what is happening in their own environment.

You will design and teach activities in your lessons that will help your students to understand the importance of this ecosystem as well as what they can do to minimise the consequences.



Types of Forests

There are different types of forest in many different environments and these are:

- a. *Tropical rainforests* - hugely dense, lush forest with canopies preventing sunlight from getting to the floor of the forest. All year high temperatures and abundant rainfall and located near the equator. This type of forest has many species of trees and is a vital storehouse of biodiversity, sustaining millions of different animals, birds, and algae.
- b. *Sub-tropical rainforests* - Located at the south and north of the tropical rainforests. Trees here are adapted to resist the summer drought.
- c. *Montane forests* - known as cloud forests because they receive most of their precipitation from the mist or fog that comes up from the lowlands. Usually found in high-elevation tropical, subtropical and temperate zones. Plants and animals in these forests are adapted to withstanding the cold, wet conditions and intense sunlight. Trees are mainly conifers.
- d. *Temperate forests* - located at Eastern North America, North Eastern Asia, and Western and Eastern Europe. Mix of deciduous and coniferous evergreen trees. Usually, the broad-leaved hardwood trees shed leaves annually. There are well-defined seasons with a distinct winter and sufficient rainfall.
- e. *Coniferous forests* - Located in the cold, windy regions around the poles. They come in both hardwoods and conifers. The hardwoods are deciduous. The conifers are evergreen and structurally adapted to withstand the long drought-like conditions of the long winters.

All forests provide shelter, homes and food for all kinds of birds, insects, tree kangaroos, pigs and cassowaries. The grouping of specific kinds of plants and animals within a specific forest type is called an *ecosystem*.

We will now look at two types of ecosystems that relate to the types of environment in Papua New Guinea. These two ecosystems are:

1. The tropical rainforest
2. The grassland

Tropical Rainforests

Stretching from the lowlands to altitudes beyond 3,000m, New Guinea's tropical forests show an enormous variety in species and dynamics depending on their location. Here the trees do not shed their leaves as the tropics experience two seasons - the wet rainy season and the dry season when there is no rain. Tropical forests have many more different types of tree species than temperate forests. In the tropics, you find high montane forest types. These consist of short trees, shrubs and grassland. As one progresses down highly mountainous areas, the forest type changes into a mid-altitude moss covered mountain trees. In the lowlands are typical rainforest trees that are valuable for the logging industry for timber.



Shoreline (Littoral) forest

Distributed along the sandy beaches and adjacent plains of the southeast and southwest coasts, shoreline (littoral) forests include common canopy trees such as the Burmese rosewood (*Pterocarpus indicus*), also known as narra or angkana, and the paper bark tree or punk tree (*Melaleuca species*). In the southwest of the island, acacia palms (*Acacia species*) are common on the ground-layer and in lower tree layers.

Swamp forests

The swamps are associated with some of the largest rivers, such as the Sepik, the Fly, the Strickland, the Mamberamo and the Purari. Sago trees, which are found close to the swamp forests, provide the staple starch for many people.

Heathland

Heath is found on poor soils in both highland and lowland New Guinea. In the lowlands, the vegetation grows on infertile soil of a sandy type. In the subalpine and alpine heaths, infertile soils support shrubs and meadows.

Savannahs and grasslands

Spread along the New Guinea's southern coast, savannahs are strangely reminiscent of the landscapes of northern Australia. Open savannah thrives in conditions that other ecosystems wouldn't be able to withstand for very long. Here, there is no more than 2,600 mm of rainfall a year. In the dry season, it gets worse. Rainfall drops to less than 100 mm per month.

Grassland

What is a grassland ecosystem? Grasslands are open areas of land where grasses or grass like plants are the dominant species. Other forms of vegetation such as trees are rare in grasslands because they are not suited to thrive in the grassland's dry environment.

The **Trans Fly Savannah and Grasslands** are a lowland eco-region on the south coast of the island of New Guinea in both the Indonesian and Papua New Guinean sides of the island. With the monsoon and dry season climate these grasslands are quite different from the tropical rainforest that covers most of the island and resembles the landscape of northern Australia which lies to the south. The name Trans Fly refers to the Fly River.

Flora

The area is mostly grassland that resembles nearby Australia and contains areas of *kamarere* forest woodland. Regular fires occur at the end of every dry season. They are not as rich in wildlife as the rainforests of New Guinea. Mammals of the area include the New Guinean planigale, bronze quoll, spectacled hare-wallaby and dusky pademelon. Birds of the area include the Fly River grassbird and the spangled kookaburra, a species of the famous relative of the kingfisher which feeds on rats, mouse and snakes and lizards rather than fish. The area has an important number of reptiles and amphibians including the unique Pig-nosed Turtle.

LESSON 9A – JUNIOR PRIMARY

Name of Lesson: The Forest Environment.

Objective: By the end of this lesson, students can:

- Identify living and non-living things in the forest environments.
- Classify living things found in the forest environments.

Key Knowledge:

1. The natural environment is made of different living and nonliving things.
2. The forest environment is made up of varieties of plants and animals.
3. Some plants and animals like to live only in forest environments.

Materials Needed: Fact sheets, information sheets, pictures and posters of forest environment including plants and animals, and Activity Sheet 2.1

Preparation: Identify a forest environment near your school for the visit. Divide the class into small work groups of 4-5 members. Appoint a person to record what they see or identify. Explain the safety measures to the class before their visit to the forest.

Activity: Outdoor Visit – Talk about the natural environment. Ask students to describe the kinds of environment they live in. Make a list of their responses on the blackboard. Explain that the natural environment has many different living and nonliving things. There are also many different plants and animals that live in each type of environment. Distribute Activity Sheet 2.1 to each group. Explain that they will go on an outdoor visit to the nearby forest. Explain that the group recorder should keep a record of five things they see or can identify during their visit on their activity sheet. After the visit, have each group share what they have seen during the visit. List these on a table as shown below:

WHAT DID YOU SEE?	WAS IT A PLANT, ANIMAL OR NONE LIVING THING?	WHAT DID IT LOOK LIKE?
Fern	Plant	Has a lot of small leaves and it's green
Palm tree	Plant	Has green leaves and a brown trunk
Butterfly	Animal	It's yellow and has two large wings
Tree Frog	Animal	Green with orange webbed feet
Small creek	Nonliving thing	Clear with small fish and creatures in it

Evaluation/Homework: Sum up the lesson by asking related questions. Give homework to students by asking them to draw pictures of plants, animals and nonliving things they saw.



Activity Sheet 2.2~ Animal, Plant or Non Living thing?

On the visit to the forest area, draw pictures or write down names of what you see. State whether it is an animal, plant or nonliving thing. You can briefly describe what it looks like.

Name of Object	Is it a plant, animal or nonliving thing?	What did it look like?



LESSON 9B – JUNIOR PRIMARY

Name of Lesson: The Grassland Environment.

Objective: By the end of this lesson, students can:

- Identify living and non-living things in the grassland environments.
- Classify living things found in the grassland environments.

Key Knowledge:

1. The grassland environment is made up of mainly grass with few or no trees.
2. Some plants and animals can be found in both environments – grassland and forest.

Materials Needed: Factsheets, information, pictures and posters of grassland environment including plants and animals.

Preparation: Identify grassland near your school and organise a class excursion there. Make sure there are other adults like parents or elders to help supervise the class. Explain the safety measures to the class before their visit.

Activity: Excursion - Talk about different kinds of natural environments. Have students describe the kinds of environments they live in. Make a list of their responses on the blackboard. Explain that natural environments have many different plants and animals that live in each type of environment. Divide the class into groups of 4-6 students. Distribute Activity Sheet 2.3 to each group. Explain that they will go for an excursion to grassland. Remind the group recorder to keep a record of five animals or plants they see during their visit.

Note: students may not get to see a variety of animals in that particular environment. A follow-up activity in the next lesson will enable students to learn more about the grassland environment.

Encourage students to describe physical features of the plants and animals they came across in their exploration. You may come up with a table like the example below:

ANIMAL/PLANT	WHAT IT LOOKS LIKE	WHAT IT EATS/WHAT IT FEEDS ON?
Bandicoot	Long body, claws, pointed face/jaws	Fallen fruits, ants, etc.
Grasshopper	Green and brown, small and big	Grass, new leaves and shoots, etc.
Grass	Some green and some brown	Eaten by grasshoppers and other insects
Butterfly	Small and yellow with wings	Small birds
Tree	Narrow leaves with small round green & yellow fruits	Beetle eat the leaves, birds feed on the fruits and shoots,

Evaluation/Homework: Sum up the lesson by asking related questions. For homework, tell students to draw pictures of one grassland animal and what it was doing during the excursion.

Activity Sheet 2.3~ What's in this Grassland?



List five (5) grassland animals and plants. Draw pictures of what each animal or plant look like. Write the name of the animal or plant it eats. If it is a plant, write the name of the animal that eats it.

Animal/Plant	What it looks like?	What it eats? /Who can eat it?



Name of Lesson: Living in the Forest Layers.

Objective: By the end of this lesson, students can:

- Describe the four layers of the forest.
- Name plants and animals that live in the different layers of the forest.

Key Knowledge:

1. The forest is divided into four layers – forest floor, understory, canopy and emergent.
2. The understory and the forest floor receive limited sunlight.
3. Some animals in the canopy and emergent layers have never been to the ground.

Materials Needed: Pictures or posters of the forest, plants and animals; markers, water colours, chart/butcher or used papers; dried or fresh flowers, leaves, sticks, soil, and natural dyes or paints.

Preparation: This activity may take two lessons to complete. Prepare two or three chart papers or used newspapers glued together on the wall. Divide students into two big groups and assign them to each corner of the room where the papers have been put up.

Activity: Rainforest Layers - Begin the lesson by talking about the different layers of the forest canopy and the kind of plants and animals that live there. That is:

- A. *Emergent Layer* – very sunny with only the tallest trees. Also known as the over story. Animals found in this layer include big birds, bats and snakes.
- B. *Canopy Layer* - Thickest layer where most trees in the forest grow to this height. Air plants grow in the canopy layer where their roots don't reach the ground. Animals found in this layer include birds, tree kangaroos, cuscus, frogs, lizards, snakes and many insects.
- C. *Understory* - dense vegetation with many vines and much sunlight. Animals found in this layer include birds, butterflies, frogs and snakes.
- D. *Forest Floor* – dark and damp layer full of many dead leaves, twigs and dead plants. Less vegetation often small stunted seedlings trees, with little or no winds and rains. Only 2% of the sunlight actually reaches the floor. Animals found in this layer include wild pigs, ground birds, bandicoots, and wallabies.

Tell the class that they will work in two groups to build a rainforest mural or painting in the classroom. Have the groups get into their allocated work corners. You can put up the picture of the different layers of the forest as shown on *page 56*. Students can use this to help them construct their mural. *Students can use both natural materials as well as those provided by the teacher.* This activity can be assessed using your own criteria.

Evaluation/Homework: Ask students to name the different layers of the forest canopy and give examples of plants animals found in each layer. For homework, students can complete decorating their mural.

LESSON 10B – SENIOR PRIMARY



Name of Lesson: Living in the Trans Fly Savannah Grassland.

Objective: By the end of this lesson, students can:

- Describe the importance of the Trans Fly Savannah Grassland.
- Recognise the endemic species of the Trans Fly Savannah Grassland.

Key Knowledge:

1. The Trans Fly Savannah grassland is an important lowland eco-region.
2. The Trans Fly Savannah grassland is home to some endemic species.

Materials Needed: Pictures and posters of Trans Fly Savannah Grassland environment, animals and plants, cardboards, A4 papers, coloured pens/pencils, sticky tape, and stapler.

Preparation: Divide the class into groups of 4 to 6 students.

Activity: Big Book – Begin the lesson by asking the class to describe what a grassland is (*Students' responses will differ according to what they already know about a grassland*). Explain that grassland is an environment that mostly comprises of grass and a few trees. Tell them that their lesson will focus on a special type of grassland called the Trans Fly savannah or grassland. Explain that Trans Fly refers to the Fly River. Ask the class to talk about where Fly River is. Link this to the Kikori River Basin and highlight the importance of some of the endemic species like the bronze quoll, spectacled hare-wallaby, dusky pademelon and the unique pig-nose turtle.

Tell the class that they are going to write a Big Book on Trans Fly Savannah grassland. Each group will collect 4-6 sheets of paper. The group can discuss about what they want to write in their Big Book. Each member will then contribute a page to this book by writing something about what they have chosen. Their writing must be big and easy to read. The description each of them writes must also be in a few words. *For example, this is a wallaby. The wallaby is hopping. It eats lots of grass. The wallaby lives in the grassland.* A good artist in the group can be asked to draw the pictures. The artist can also design the front and back covers. These should be made out of two pieces of card board, the same size as the A4 paper.

*Note: 1. The best completed books can be presented to grades 1 and 2 to use as readers.
2. This task can also be assessed using your own criteria.*

Evaluation/Homework: Ask students related questions on the importance of Trans Fly savannah and grassland. For homework, ask them to complete adding the finishing touches to their big books.

TOPIC 3: AQUATIC ECOSYSTEMS

Introduction

Papua New Guinea has a high concentration of different aquatic ecosystems. *Aquatic ecosystem refers to the ecosystems that are filled with water all year round.* An aquatic ecosystem is an ecosystem in a body of water. Communities of organisms that are dependent on each other and on their environment live in aquatic ecosystems.

Some aquatic ecosystems such as huge river systems, streams and creeks, ponds, swamps, lakes and wetlands, and coastal mangrove forests, estuaries and river delta regions, and seas and oceans are huge ecosystems.



Fig 17 Suki Lake & swamp, Western Province. Photo: Kyaro@WWF/2012

Papua New Guinea's aquatic ecosystems are varied and range from marine and estuary ecosystems to freshwater ecosystems. The estuary ecosystems are found along the coast near the mouths of many of PNG's river systems. The freshwater ecosystems range from rivers, lakes, creeks to streams. PNG's marine ecosystems are also very rich in biodiversity and occur along the coastal areas.

The aquatic systems comprise of three main types – *marine ecosystems, estuary ecosystem and freshwater ecosystems.*

A. Marine Ecosystems

Marine ecosystems are the largest of Earth's aquatic ecosystems. They are distinguished by waters that have a high salt content. The freshwater ecosystems have a lower salt content. Marine waters cover more than 70% of the surface of the Earth and account for more than 97% of Earth's water supply and 90% of habitable space on Earth.

They are characterised by the biological community of organisms that they are associated with and their physical environment. Marine ecosystems include those that are near the shore such as:

- Salt marshes,
- Mudflats,
- Seagrass meadows,
- Mangroves,
- Rocky intertidal systems
- Coral reefs.

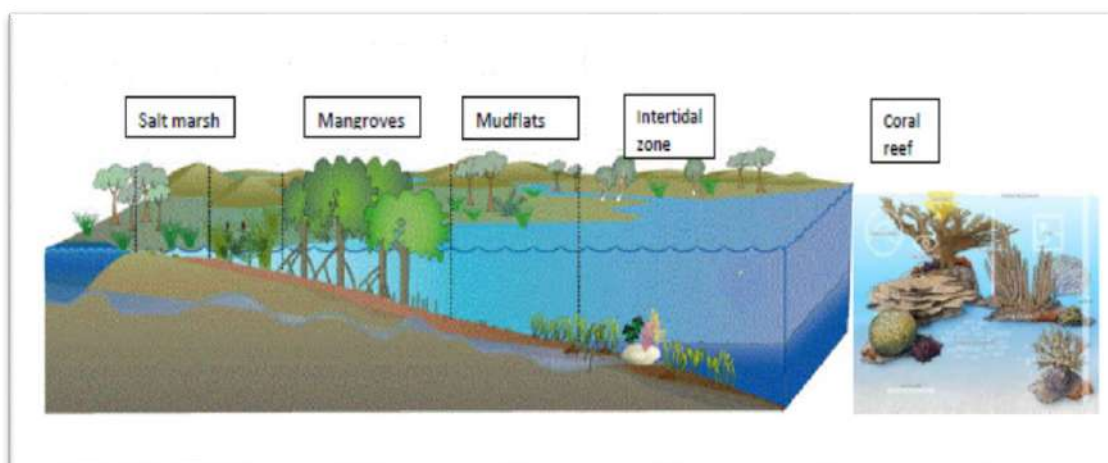


Diagram 4 Illustration showing some marine ecosystems⁹

(i) Salt marsh


Salt marshes are a transition from the ocean to the land where fresh and salt water mix. The soil in these marshes is often made up of mud and a layer of organic material called peat.

Salt marshes exist around the world and are needed for healthy ecosystems and a healthy economy. They are extremely productive ecosystems and they provide essential services for more than 75 percent of fishery species and protect shorelines from erosion and flooding.

(ii) Mangroves

Mangroves are trees or shrubs that grow in low-oxygen soil near coastlines. They are an extremely productive and complex ecosystem that connects the land and sea.

⁹ Source: google.com



Mangroves can often be recognised by their thick web of roots that act to protect the coast by reducing erosion from storm surges, currents, wave, and tides. The mangrove ecosystem is also an important source of food for many species of marine life.

(iii) Intertidal zones

Intertidal zones are the areas that are visible and exposed to air during low tide and covered up by saltwater during high tide. Due to the large variance of conditions possible in this region, it is inhabited by resilient wildlife that can withstand these changes such as barnacles, marine snails, mussels and hermit crabs.

Tides flow over the middle intertidal zone two times a day and this zone has a larger variety of wildlife. The low intertidal zone is submerged nearly all the time except during the lowest tides. Life is more abundant here due to the protection that the water gives.

(iv) Coral reef

Coral reefs are one of the most well-known marine ecosystems in the world, the largest being the Great Barrier Reef. These reefs are composed of large coral colonies of a variety of species living together. The corals form multiple symbiotic relationships with the organisms around them.

The deep sea contains up to 95% of the space occupied by living organisms. Combined with the sea floor (or benthic zone), these two areas have yet to be fully explored and have their organisms documented.

B. Estuary Ecosystems

An estuary is a partially enclosed body of water formed where a river flows into an ocean. Estuaries are the areas between *terrestrial and marine* ecosystems. Estuaries are where freshwater mixes with salt water, so many estuaries are typically at the mouth or near the mouth of rivers. Because estuaries have a mixture of fresh water and salt water, they support ecosystems that have a unique and diverse community of organisms. Seagrasses, mangrove trees, fish, oysters, mussels, and water birds all live in estuaries.

These areas are swampy and typically in the tropics. Estuaries have mangrove forests. Mangroves provide nursery habitats for fish, prawns, mud crabs and shellfish. Mangrove trees also provide strong timber for house posts and firewood. Mangroves are protection systems against heavy wave and wind storms. Mangroves and the animal life in estuaries form unique ecosystems as mangroves are the only evergreen trees that can live in salt water. The mixture of salt water and nutrient-rich fresh water in an estuary supports breeding grounds for birds, commercial fish, and shellfish. The grasses in estuaries protect coastal areas from erosion and flooding.

The wildlife found within these ecosystems is quite unique. Estuaries are extremely productive ecosystems that many humans and animal species rely on for food. Estuaries are also very important ecosystems as they assist in water filtration, habitat protection, erosion control, gas regulation and nutrient recycling. They also provide education, recreation and tourism opportunities to people.

C. Freshwater Ecosystems

Freshwaters comprise of all rivers, lakes, swamps, peat bogs, streams and creeks, underground springs and rivers found all over the earth. Underground rivers and springs form ecosystems where specialised life forms exist. On land, the rivers and streams forms freshwater, therefore have freshwater fish and prawns and plants that live inside are called aquatic plants.

In Papua New Guinea, the freshwater ecosystems are varied and contain variety of species. Rivers, natural and human made lakes e.g. Yonki Lake, creeks, streams, and springs. The following is a brief explanation of the types of fresh water ecosystems:

Lakes and Ponds

Lakes and ponds (see Fig.18) contain single celled micro-organisms called protists, such as algae and amoebas, as well as the eggs and young of frogs and some insects. Clams, bacteria, and worms live on the bottom of lakes and ponds and break down dead materials for food. Frogs, turtles, fish, and ducks have adaptations that let them swim in lakes and ponds.



Fig. 18 Illustration of lake & pond ecosystem¹⁰

PNG has a number of lakes with the main ones being Lake Murray in Western Province and Lake Kutubu in Southern Highlands Province. There are marine lakes on land such as Lake

¹⁰ Pinterest.com

Dakataoa in the Williamueze Peninsula in West New Britain Province. All freshwater plants and animals such as fish cannot live in salt water. Other major lakes include Lake Kopiago, Lake Murray, Lake Labu, Wagu Lake, and Murik Lake. There are also human-made lakes like the Yonki Lake in Eastern Highlands Province.

Lake Kutubu is a large freshwater lake in the Southern Highlands Province. It holds twelve (12) exotic and endemic rainbow fishes found nowhere else on earth. The Lake Kutubu has underwater plants that live in the water and provide a habitat and feeding areas for the fish.

Rivers


Rivers and streams (see Fig.19) including *creeks* are also home to many organisms, including fish, aquatic insects, and mosses. As the water moves, it interacts with air and absorbs oxygen. Freshwater ecosystems in streams can have areas of fast-moving and slow-moving water, with organisms adapted to each area.



Fig. 19 Illustration of stream ecosystem¹¹

In New Guinea, the rivers rival terrestrial ecosystems in terms of complexity and diversity. They are home to crocodiles, freshwater sharks, barramundi and hundreds of other fish species. They are also an integral part of the forest ecology. Some of the world's great rivers flow

¹¹ Depositphotos.com



through the island's forests, including the Asmat and Mamberano rivers in Indonesia's Papua Province, and the majestic Sepik River in Papua New Guinea.

The Sepik is the longest river on the island of New Guinea with the length of 1,126 km¹² and passes through the East and West Sepik Provinces with a small portion in the Indonesian Province of Papua. The Sepik has a large catchment area and landforms that include swamplands, tropical rainforests and mountains. The river is believed to be biologically the largest uncontaminated freshwater wetland system in the Asia-Pacific Region although there have been some introduced fish and plant species since the mid 20-century.

The Fly River is the second longest river in Papua New Guinea, after the Sepik at about 1050 km. By volume of discharge the Fly is the largest river in Oceania, the largest in the World without a single dam in its catchment and overall the 25th largest primary river in the world¹³. The Kikori River is also another very important freshwater ecosystem and is the focus of this resource book. It is about 320 km long and flows southeast into the Gulf of Papua with its delta at the head of the Gulf.

The Kikori river system is known for its biodiversity. Mt Bosavi lies on the western edge of the Kikori River Basin. The catchment is with more than 100 species of fish, of which 14 per cent are endemic. It is also said to be the most species rich river in New Guinea. However, most of the endemic species are in Lake Kutubu¹⁴.

¹² Wikipedia.com

¹³ Wikipedia.com

¹⁴ Wikipedia.com

LESSON 11A – Junior Primary

Name of Lesson: My Freshwater Ecosystem.

Objective: By the end of this lesson, students can:

- Name the freshwater ecosystems in their local environments.
- Identify living and non-living things that live in a freshwater ecosystem
- Discuss how these living and non-living things interact with each other

Key Knowledge:

1. Freshwater ecosystem is a type of aquatic ecosystem.
2. There are different types of freshwater ecosystems – some on the land and some underground.
3. Aquatic plants and animals live in the freshwater.


Materials Needed: Pictures and posters of a pond, lake or swamp showing living and nonliving things in that ecosystem; flash cards of the different organisms in each of the above ecosystems, student worksheets and information sheets.

Preparation: This activity may take up two lessons. If your school is situated near a swamp, pond, stream, creek or lake then carry out activities that are easily implementable for your classes. You may carry out the suggested activities but ensuring that you use posters, information and facts sheets or other resources to teach the children about the importance of these habitats.

Activity: Exploring Freshwater Ecosystem - Begin a class discussion by asking the children to talk about their own knowledge of the types of plants and animals that live in the above freshwater ecosystems (i.e. river, swamp, pond, stream, creek or lake depending on where they live). Make note of these points on the chalkboard. Explain to students that they are to observe plants, animals and other nonliving things in the freshwater ecosystem that you have selected. Each group is to find and identify at least four (4) to six (6) objects. Ask them to make a list of these on a table as shown below:

NAME OF ECOSYSTEM	OBJECTS SEEN	ANIMAL, PLANT OR NON LIVING THING
Lake	Mud	Nonliving thing
	Rainbow fish	Animal
	Water Lily	Plant
	Water	Nonliving thing
	Water grass	Plant
	Frog	Animal

After returning to the classroom, each group then presents their findings to the class. Ensure that you compile their responses on the board and compare for discussions. Ask follow up questions as shown below and discuss their responses:

- 
- a. Is this object a living or nonliving thing?
 - b. If it is a living thing, does it make its own food or feed on other things?
 - c. If it feeds on other things, what kinds of things does it eat? Make a list of at least three (3) things it feeds on.
 - d. Is it eaten by animals? If yes, name three (3) animals that eat it.

Make sure to list students' responses on the board. Based on their responses, draw illustrations of simple feeding relationship.

Tell the students that plants and animals can be observed in many different ecosystems. Observations help us to understand how all living things work together to make up an ecosystem. Oceans, swamps, or rivers may all contain very different living organisms and other nonliving components. All living components need energy to live. These are obtained from their feeding relationships based on what they feed on. Animals eat plants and other animals in the ecosystem in which they live.

Evaluation/Homework: Remind students that plants and animals can be observed in many different ecosystems. Observations help us to understand how all living things work together to make up an ecosystem. For homework, students will draw pictures to show the feeding relationships between plants and animals listed on the table. These can be used for class discussion.

Assessment Activity: You can assess students based on their responses to the above four (4) questions. Students' written responses can be marked using a criteria.

LESSON 11B – Junior Primary

Name of Lesson: My Estuary Ecosystem.

Objective: By the end of this lesson, students can:

- Recognise the estuary ecosystem that forms part of their local environments.
- Identify living and non-living things that exist in an estuary ecosystem.

Key Knowledge:

1. Estuary ecosystem is a type of aquatic ecosystem.
2. Estuary ecosystem contains variety of plants and animals.

Materials Needed: Pictures and posters of an estuary showing mangroves and living organisms in that ecosystem, flash cards of the different organisms in the estuary ecosystem.


Preparation: This activity may take up two lessons. If your school is situated near an estuary then visit it first. If you are not located near the estuary, use posters, facts sheets or other resources to teach the children about the importance of this habitat.

Activity: Exploring an Estuary - Begin by asking the children if they know where the river, creek or stream ends up. Use this to introduce the estuary ecosystem. (*An estuary is a special name given to the habitat where the rivers/streams meet the sea or the river mouth*). Have a class discussion by asking the children to talk about the types of plants and animals that live in the estuary ecosystems. Make note of these points on the chalkboard.

If your school is not near an estuary, use posters, factsheets and other resources to generate discussions on the kind of plants and animals in this ecosystem. If the school is near an estuary, take a class excursion there. The task is for each group to identify at least four (4) to six (6) objects in an estuary. Help the groups to identify living and nonliving things in the estuary. Ask them to make a list of these on a table as shown below:

OBJECTS SEEN	ANIMAL, PLANT OR NON LIVING THING
Sand	Nonliving thing
Sea eagle	Animal
Marsh grass	Plant
Water	Nonliving thing
Sea grass	Plant
Kingfisher	Animal
Fish	Animal
River or creek	Non living

Each group then presents their findings to the class. Ensure that you compile their responses on the board and compare for discussions. Ask the follow up questions as shown below and discuss their responses:

- 
- Name three (3) common animals in the estuary. What does each of these animals feed on?
 - Name one common plant in the estuary. Name two (2) animals that feed directly on this plant.
 - Draw a picture to show what an estuary looks like. Include plants and animals. Colour the picture when you finish. Use Activity sheet 2.4 to draw your picture.

Make sure to list students' responses on the board. Use their responses to elaborate on the importance of the estuary ecosystem in the protection of the coastline. Emphasise the importance of different plants and animals found in this ecosystem.

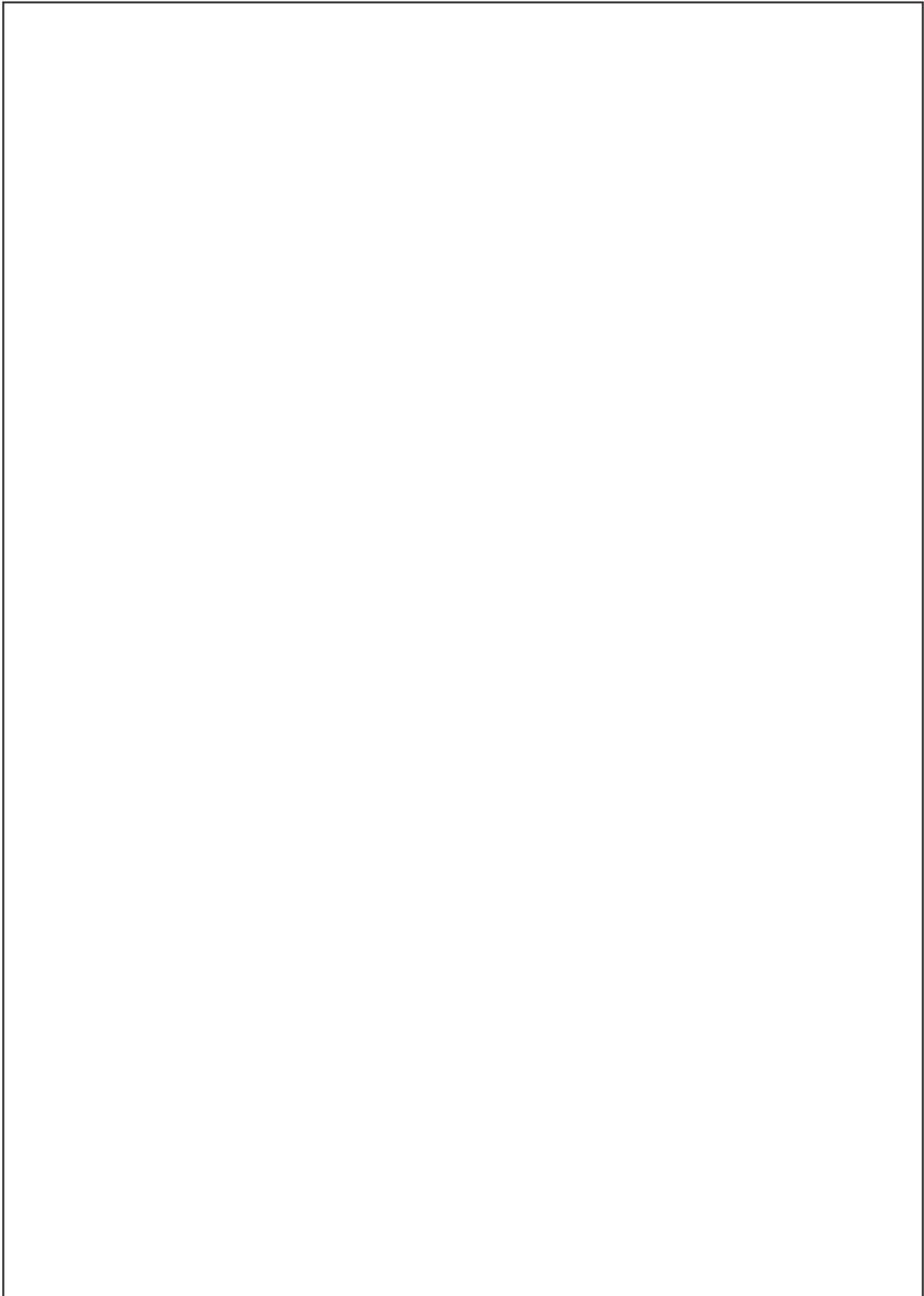
Evaluation/Homework: Remind the class that different plants and animals are found in different ecosystems. Living things work with each other and their nonliving parts of the environment to survive. For homework, the class can complete their pictures and colour this.

Assessment Activity: This is an assessable activity. You can assess your students on their ability to work together as a team. You can also assess them on their ability to correctly identify the kind of plants and animals that live in the estuary.



Activity Sheet 2.4~ Life in the Estuary

Draw a picture of an estuary ecosystem. Show plants and animals that live here. Colour your picture.



LESSON 12A – Senior Primary

Name of Lesson: Freshwater Ecosystem.

Objective: By the end of this lesson, students can:

- Describe the animals that exist in a freshwater ecosystem.
- Describe special features of plants that exist in a freshwater ecosystem.
- Write up a food web comprising of two or more food chains in a freshwater ecosystem.

Key Knowledge:

1. Freshwater contains a variety of living and nonliving things.
2. The Sun is the original source of energy for all living things.
3. Freshwater plants need energy from the Sun to produce food. These foods contain energy for all living things in that ecosystem.
4. Plants are called primary producers. They need water, carbon dioxide, chlorophyll and energy from the Sun to grow the leaves and fruits that are consumed by animals.
5. Animals are consumers. Some are primary consumers while others are secondary and tertiary consumers.

Materials Needed: Pictures and posters of a pond, lake or river showing all living organisms in that ecosystem; posters of food chains, food webs and food pyramids; flash cards of the different organisms in each of the above ecosystems, student worksheets and information sheets.


Preparation: This activity may take up two lessons or more. If your school is situated near a swamp, pond, stream, creek or lake then visit these site. Carry out the suggested activities using posters, information and facts sheets or other resources.

Clearly explain the group activity to your class ensuring that they understand your instructions which is to observe, identify and describe the organisms.

Activity: Freshwater Ecosystem- Begin a class discussion by asking the students to talk about their own knowledge of the types of plants and animals that live in the above freshwater ecosystems. Make note of these points on the chalkboard.

Tell the class that they will visit a freshwater ecosystem and observe plants and animals that live there. Each group is to find and identify at least five (5) organisms. Help the groups to identify producers and consumers. Ask them to note such things as size, colour, mouth parts and how they move. Encourage them to determine what function each organism serves. *They may ask you if they find it difficult to identify producers or consumers.*

Students will complete the table in *Activity Sheet 2.5* and discuss their results in their groups. Each group then present their findings to the class. Ensure that you compile and compare their results. *Use students' responses to draw up food chain and food web.*



Explain some of the food relationships that exist among these organisms and emphasise the fact that millions of smaller organisms support a small number of bigger animals because of the loss of energy between energy levels (e.g., through respiration, movement and waste products). Show students the Food Pyramid Chart so that they can get a better idea of the energy flow and the numbers of smaller organisms required to support a few larger organisms in the higher energy levels.

To conclude, tell the students that energy from the sun is transformed into food energy by plants through a process called photosynthesis. Plants are the producers. They need water, carbon dioxide, chlorophyll and energy from the sun to grow the leaves and fruits that are consumed by animals. Animals that eat plants are called primary consumers. Some animals, called secondary and tertiary consumers, eat other animals for food. Within an ecosystem, decomposers might be called the recyclers. These organisms, such as bacteria and fungi, breakdown organic matter into basic nutrients that may be reused by other living things. This flow of energy from one living thing to another is called a food chain.

Evaluation/Homework: Remind students that energy from the sun is transformed into food energy by green plants through photosynthesis. Plants are the producers. They grow leaves and fruits that are consumed by animals. For homework, students can draw a food chain and food web and label the different plants and animals. They may use the words producers consumers, etc.

Assessment Activity: This is an assessable activity. You can assess students work by writing a set of questions for students to write their responses for marking. Here is a sample:

- (i) What is the role of this organism? Is it a producer or consumer?
If it is a consumer, what does it eat? Is it eaten by any other organisms?
- (ii) What is the energy source for a producer?
- (iii) What is the difference between primary and secondary consumers?
- (iv) What are decomposers? What do they do?
- (v) Which organisms were most abundant? Producers, primary consumers, secondary consumers or tertiary consumers? What could be a possible explanation for this?
- (vi) How does energy flow through the food chain?
- (vii) How many examples of a food chain can we list using these organisms?
Can we connect some of these chains together?
- (viii) How would you describe a food web?

Student worksheet 2.5~ Freshwater Ecosystem

Identify five (5) organisms you can find during the class excursion. Write their names on the space provided. Carefully observe its features and record it down.

Name of Organism	Role of organism i.e. producer, consumer, decomposer	Description of organism i.e. mouthparts, size, colour, how it moves, etc.	What it feeds on

LESSON 12B – Senior Primary

Name of Lesson: Mangrove Ecosystem.

Objective: By the end of this lesson, students can:

- Describe some animals that exist in the mangrove ecosystem.
- Describe special features of plants that exist in the mangrove ecosystem.
- Write up a food web comprising of two or more food chains in a mangrove ecosystem.

Key Knowledge:

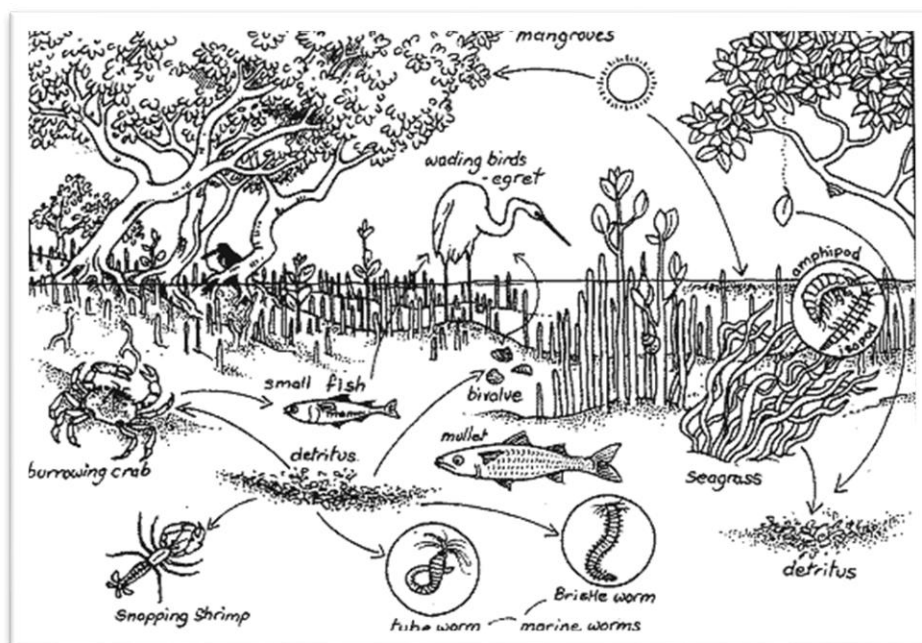
1. Mangrove ecosystem contains a variety of living and nonliving things.
2. Feeding relationship in a mangrove ecosystem is of two types – one begins with green plants and the other begins with detritus (dead and decaying matter) in the water.
3. All energy used by plants or found in the detritus start from the sun.

Materials Needed: Pictures and posters of a mangrove showing all living organisms in that ecosystem; posters of food chains, food webs and food pyramids; flash cards of the different organisms in the mangrove ecosystems, student worksheets and information sheets.


Preparation: This activity may take up two lessons or more. Carry out the suggested activities using posters, information and facts sheets or other resources.

Activity: Understanding Mangrove Ecosystem- Begin a class discussion by asking the students to talk about their knowledge of the mangrove habitat and the types of plants and animals that live there. Make note of these points on the chalkboard.

Put up a poster on the mangrove ecosystem such as the one below.



Ask the class to use the poster to identify plants and animals that live in the mangrove ecosystem. Each group is to identify at least six (6) organisms. Help the groups to identify



producers and consumers. Ask them to determine what function each organism serves. Group responses can be shown in the table like the one below.

OBJECTS FOUND IN THE MANGROVE ECOSYSTEM	ANIMAL, PLANT OR NON LIVING THING
Mangrove tree	Plant
egret	Animal
Burrowing crab	Animal
seagrass	Plant
mullet	Animal
detritus	Nonliving thing
Water	Nonliving thing
Sun	Nonliving thing

Students can complete their discussions present their results to the class. Ensure that you compile and compare their results. Ask the students to draw up two food chains – one beginning with a plant and the other with detritus. Have each group present their responses. Use these to construct a mangrove food web.

Explain some of the food relationships that exist among these organisms and emphasise the fact that millions of smaller organisms support a small number of bigger animals because of the loss of energy between trophic levels (e.g. through respiration, movement and waste products).

Evaluation/Homework: Remind the students about the importance of the mangrove ecosystem. For homework, students can draw a food chain and food web and label the different plants and animals. They may use the words producers, consumers, etc.

UNIT 3: BIODIVERSITY AND CONSERVATION



Photo: Lake Kutubu
Flora@Kyaro/WWF/2019


Introduction

The landscape of the Kikori River Basin has unique ecological, cultural, and economic significance. Each of these is connected to the vast intact rainforests in the region which is also the largest remaining tract of undisturbed rainforest in the Southern Hemisphere. This stretches from alpine and montane forests in the north to rare intact lowland forests in the south.

The ecological vastness of Kikori River Basin also influences its many unique cultures and customs. It also contains many newly described and undescribed species. The Kikori River Basin is recognised as one of the most important areas of forest and wetlands biodiversity in the Asia-Pacific region. Such a world treasure right at our door step needs to be protected!

TOPIC 1: WHAT IS BIODIVERSITY?

Biodiversity comes from two words; *biological* and *diversity*. Biological is another term referring to all living organisms, including plants, animals and humans that form life on Planet Earth. Diversity is referring to variations, uniqueness and spectacular differences and/or similarities of life forms on earth.



Therefore, as we look around our homes, villages, district, provinces, PNG and the planet, we see different types of plants and animals occurring in different ecosystem types. For example; many different kind of trees, vines, palms, orchids and rattan in the forests ecosystem. As we learned in Unit 2, different kinds of animals live in the forest ecosystem from the coastal areas to the highland areas. Similarly, many different plant and animal life thrive in aquatic ecosystems. For example, mangrove trees, sago palms, swamp pandanus, swamp pitpit and grass species. There are many different animal species that live in the aquatic ecosystems; the fish, water birds, eels, mud-skippers, crustaceans and many other aquatic animal and insect species. Thus, many different plant and animal life adapt to different ecosystem types.

Plants and animals survive in the habitats and ecosystems that they are best suited. Should they be displaced for some reason, they will face problems trying to adapt in order to survive in that new environment. Or, if their habitat or ecosystem is disturbed, they will face threat and eventually get extinct in their habitats, ecosystems and even from this planet Earth.

For example, mangroves trees belong to mangrove or coastal ecosystem and they are especially found in the coastal areas. They do not grow inland. In the inland areas, we have trees that also grow in swampy areas and not on the ridge tops. The ridge tops have different trees again, whilst high mountain tops like Mt. Giluwe and Mt. Wilhelm have ice and no trees growing there. Different types of animals like birds, pigs, wallabies and possums live throughout the forests eating from fruit trees within their specific habitats and ecosystem types. We have learned in Unit 2 that there are many different ecosystem types. In these ecosystem types, there are many different kinds of plants and animals living there and they are associated with that type of ecosystem.

In the same way, animal species all over the world are different in different countries. For example, elephants, lions, tigers and hippopotamus only live in Africa while cuscus, tree kangaroos, birds of paradise, and pig-nosed turtles only live in PNG. Differences in animal colours, shapes and types also differ from country to country. Many species of plants and animals are harvested commercially and as a result they become rare, threaten and endangered or near extinct or totally extinct, and therefore need international protection.

The United Nations Development Programme established a Convention or Agreement to protect such plants and animals. The Convention is called the Biodiversity Convention and calls nations to protect and conserve biodiversity.

The Kikori River Basin's Biodiversity Values

The Kikori River Basin is home to 24 of the 38 Birds of Paradise species, the world's only poisonous bird or the Pitohui, the world's rarest underground roosting bird (*Melampitta gigantean*), and the New Guinea flightless rail (*Megacrex inepta*), one of PNG's rarest birds. In addition, the area contains three rodent species which are new to science, and a recently discovered blossom bat which is not yet described by scientists. Its freshwater systems are

home to at least 15 endemic freshwater fish of which three are new to science, and 28 undescribed frog species of which four have been recently confirmed as new species.

There are 20 undescribed orchid species recorded around the Lake Kutubu area alone, and two are undescribed species of palm trees (WWF unpublished report, 2005). Last but not the least, the Kikori River Basin landscape, is the home of three of WWF's flagship species, the pig-nosed turtle, tree-kangaroos, and the inshore river dolphins.



Fig.20 The Tree Kangaroo (left), Daga Villages and the Cuscus (right). Kutubu Region © Mark Bristow / WWF /Pacific



Fig. 21 Two flagship species of the Kikori River Basin, the Pig-nosed turtle (left) and the inshore dolphin¹⁵ right.

¹⁵ Source: google.com

LESSON 13A – Junior Primary

Name of Lesson: Animals of Kikori River Basin.

Objective: By the end of this lesson, students can:

- Identify at least three (3) special animals of the Kikori River Basin.
- State two (2) important values of animals of Kikori River Basin.

Key Knowledge:

1. Kikori River Basin has many different land and water animals.
2. These animals are important to the people and environment as food sources and for cultural reasons.

Materials Needed: Pictures and posters of animals of the Kikori River Basin, A4 or A3 papers, student worksheets and information sheets.

Preparation:

Plan a visit during class time to an area near your school where your class can see the special animals from Kikori River Basin. Use posters, information and facts sheets or other resources to help your class. Make sure your instructions are very clear. Students must know what is expected of them in that lesson.

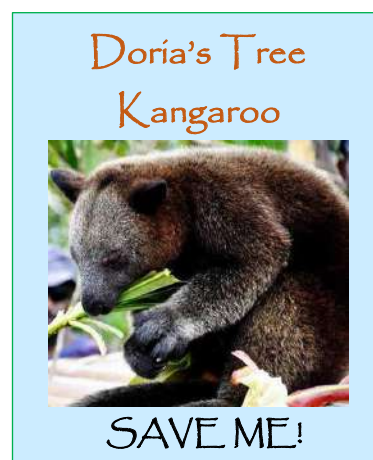
Activity: Scavenger Hunt - Take the class outside for 10 –15 minutes. Ask them to look for two (2) animals including insects. Return to the classroom and discuss their findings. Make note of these points on the blackboard.

Explain to students that there are many animals all around them – *in the forest, freshwater lake, river and on mountain tops*. Many of these animals are special to their environment. Ask the class to draw a poster of an important animal in their environment. Have the class colour their pictures and write a short message for people to see.

Note: You can modify the lesson or develop additional lesson plans to suit your class levels.

Evaluation/Homework: Review the main points by asking the class to name two animals of Kikori River Basin. Students can also complete the posters for homework.

Assessment Activity: You can assess students' posters. Develop your own criteria.





LESSON 13B – Junior Primary

Name of Lesson: Plants of Kikori River Basin.

Objective: By the end of this lesson, students can:

- Identify at least three (3) special plants of the Kikori River Basin.
- State two (2) important values of plants of Kikori River Basin.

Key Knowledge:

1. Kikori River Basin has many different plants of the forest and wetlands.
2. Plants provide food sources for people and animals.
3. Plants are important for cultural uses like making canoes and traditional costumes.

Materials Needed: Pictures and posters of the plants of Kikori River Basin, student worksheets and information sheets.

Preparation: Use pictures to help students identify special local plants. The pictures can be prepared beforehand i.e. a photograph, poster or a picture drawn on A4 paper with actual colours. If there are knowledge keepers in the area, ask them to give a talk to the class.

Activity: Spot the Plant: Ask the class to think about plants in their community and its uses. Explain that in this lesson, they will firstly listen to an elder who knows about plants who will speak to them. After listening to the talk, give each group two pictures of plants (some of these plants will already have been talked about by the elder e.g. sago, pandanus, ground orchid, arboreal orchid, nipa palm, *Digaso* (*Camposperma* spp.) and other significant plants in the Kikori River Basin). Tell the class that they will do an activity where they will use this picture to find and observe the actual plant near the school. Take the children outside the classroom for 20 – 30 minutes. Ask them if they can spot their plant. Once they spot it, they can observe it closely and complete the descriptions on their class *Activity Sheet 3.1*.

Return to the classroom and discuss the findings. Make note of these points on the chalkboard as groups present them.

Evaluation/Homework: Remind the students that Kikori River Basin is home to a variety of biodiversity. Some of these are endemic and hold world records. Recognising the values of these species enable us to appreciate and look after them. Students can complete colouring their pictures for homework. These can be used for class discussion.

Student Worksheet 3.1 – Spot the Plant!

Look around you. Can you spot the plant in your picture?

1. Name of plant: _____

2. Where did you see it – *trees, palms, vines, orchids, ferns or ground?*

3. Does it have flowers? *Yes/No* _____

If yes, what is the colour? _____

4. Does it have fruits? *Yes/No* _____

If "Yes", is it young, matured or ripen fruit? _____

5. Draw a picture of your plant and colour it. Note: If the plant is too big to draw, only draw the part with either branch, leaves, flowers or fruits.



LESSON 14A – Senior Primary

Name of Lesson: Biodiversity of Kikori River Basin.

Objective: By the end of this lesson, students can:

- Describe the different biodiversity of the Kikori River Basin.
- Identify at least two (2) special plants and animals of the Kikori River Basin.

Key Knowledge:

1. Kikori River Basin has one of the most important forest and wetlands biodiversity in the region.
2. Biodiversity refers to different types of living things such as plants and animals.
3. Biodiversity of the Kikori River Basin is important to the people living there.

Materials Needed: Pictures and posters of plants and animals of the Kikori River Basin, student worksheets and information sheets.


Preparation: Help your students to learn about different plants and animals of the Kikori River Basin. Second, give them the opportunity to create awareness on these animals and plant through posters, brochures and leaflets. If one or more of these animals and plants live near your school environment, then organise a field visit to this site during class time. Use posters, information and facts sheets or other resources to carry out suggested activities.

Activity: Biodiversity Survey – Explain to the class that in this lesson they will carry out a survey to find out what kind of plants and animals live in their environment. Have students work in six groups of 5 or 6 students. Distribute *Activity Sheet 3.2* to the class and explain their tasks. Take the class outdoors to do their survey. Have each group complete their activity task. For example, see table below.

NAME OF ORGANISM	HOW MANY DID YOU SEE?	WHERE DID YOU SEE IT – TREES, GROUND OR IN THE WATER?
Sago Palm (plant)	5	On the ground and in the water
Bird of Paradise (animal)	2	On the trees
Ground Orchid (plant)	11	On the ground
Tree Kangaroo (animal)	1	On the tree

Have a class discussion by asking the following questions:

- (i) Which organism seemed to be abundant? Why was that so?
- (ii) Which organism was least in number? Give a reason for this.
- (iii) Where were most organisms found? What do you think is the reason for this?
- (iv) Is there a relationship between the organisms that were abundant and the environment you visited? If so, what is it?



Note: The abundance of a particular organism is also determined by the kind of habitat it is found in. For example, if birds of paradise are abundant, then the habitat must be a rainforest with lots of trees. If sago palms are abundant, then it must be a swampy forest and so on. The important thing is that students are able to identify which organisms are associated with which habitat types.

Tell the students that Kikori River Basin is home to a variety of biodiversity. Some of these are rare, threaten and endemic and they hold world records. Recognising the value of these species enable us to appreciate and look after them.

Evaluation/Homework: Remind students that the environments of Kikori River Basin are very rich with different types of biodiversity. This is because there are more than one type of habitat i.e. there are forests and wetlands in the region. For homework, students can write a report of their survey which can be assessed.

Assessment Activity: Students' report can be assessed based on criteria. For example:

- Introduction (1 mark)
- Discussion of method used (2 marks)
- Discussion of results (3 marks)
- Conclusion (2 marks)
- Neatness and presentation (2 marks)

Student Worksheet 3.2~ Biodiversity Survey

Look around you. What kind of organisms can you see? Make a list of these organisms on the table below. Take note of how many you see as well.

Name of Organism	How many did you see?	Where did you see it – Trees, Ground or in the Water?

LESSON 14B– Senior Primary

Name of Lesson: Values of Biodiversity in Kikori River Basin.

Objective: By the end of this lesson, students can:

- State the ecological values of the biodiversity of Kikori River Basin.
- Describe the different plants and animals of the Kikori River Basin.
- Describe the relationship between different habitat type and plants and animals in the Kikori River Basin.

Key Knowledge:

1. Kikori River Basin has one of the most important forest and wetlands biodiversity in the region.
2. Kikori River Basin has both newly described and undescribed species.
3. Kikori River Basin has three flagship species – the Pignose Turtle, Tree Kangaroo and Inshore River Dolphin.

Materials Needed: Pictures and posters of the plants and animals of the Kikori River Basin, student worksheets and information sheets.


Preparation: This activity may take two lessons. First, help students to learn about several species in the Kikori River Basin. Second, give them the opportunity to create awareness on these species through posters, brochures and leaflets. If one or more of these species live near your school environment, then organise a field visit to this site during class time. Use posters, information and facts sheets or other resources to carry out suggested activities.

Activity: Exploring Unique Species of Kikori River Basin – Begin the lesson by taking students out of the classroom for 10-15 minutes. Explain that they will find and identify at least three (3) plants and three (3) animals including insects. When they finish, they should return to the classroom and discuss their findings. Make note of these points on the chalkboard.

Explain that there are many more plants and animals all around them – in the forest, freshwater lakes, rivers and on mountain tops. Many of these plants and animals are special to their environment; some have been described by scientists while there are others that have not been described yet.

Distribute pictures of several endemic and flagship species to each group. Example, Pignose Turtle, Inshore River Dolphin, Tree Kangaroo, Endemic Fish Species, Cuscus, Bird of Paradise, Poisonous Pitohui, and the underground roosting bird (*Melampitta gigantean*). Have each group discuss the value of each of the species. Note the discussions on the blackboard as shown on the table below:

SPECIES NAME	VALUE OF SPECIES
Pignose Turtle	Endemic; ecological and cultural importance



Poisonous Pitohui	Endemic; ecological importance
Ground Orchid	Endemic; ecological importance
Tree Kangaroo	Cultural and ecological importance
Bird of Paradise	Cultural and ecological importance
Native fish species	Endemic; ecological importance

Ask the class to draw a poster, produce a pamphlet or factsheet of this species to make people aware of this important species.

Evaluation/Homework: Tell the class that Kikori River Basin is home to a variety of biodiversity. Some of these are rare, threaten and endemic and hold world records for their conservation status. Recognising the values of these species enable us to appreciate and look after them. For homework, students can complete their posters. These can be used for school and community awareness.

Assessment Activity: The poster is an assessable activity. You can assess students based on criteria. For example:

Completed poster & impression (3 marks)

Clear message and pictures (4 marks)

Neatness and presentation (3 marks)

TOPIC 2: WHAT IS CONSERVATION?

Conservation means to use with some restrictions by leaving or setting aside a resource or asset for later use, be it in the coming months, years or into the future. With that in mind, conservation means *to set aside forests, land, coral reefs and other natural resources and places for future generations to use*. This meaning of conservation applies to resources and places that groups of people exploit to make a living out of it.


A second meaning is to do with nature itself. Nature has its own means and ways to maintain itself. For example, a tree when cut down, new shoots will grow without any effort on man's part. Also the environment cleans itself when dead trees fall, dead wood decomposes and becomes dust again; or fruit trees will put out flower during the fruiting season without any effort from human beings. This means that nature needs man to be responsible in using it.

Nature must be protected. In PNG we have areas that are protected by law such as the Conservations Areas Act, and the Protected Areas Policy. These laws require clans and provinces to set aside forest areas, land, mangroves and coral reef areas as Protected Areas. These protected areas will hold and keep the plants and animals alive for today and into the future. An example of a protected area is the Lake Kutubu Wildlife Management Area which protects the endemic fish species, Birds of Paradise, possums, the natural forests and swamp wetland area. It also protects the freshwater and aquatic life forms. Maza Wildlife Area in Western Province protects the coral reefs of the Warrior Reefs and the mangrove ecosystem in that province. There are many more Wildlife Management Areas through-out the whole country; both terrestrial and marine protected areas.



Fig. 22 Pignose Turtle, an iconic species from the Kikori River Basin¹⁶

¹⁶ Original source: Wikipedia.com



Since Kikori River Basin has some endemic species like the Pig Nose Turtle and The Inshore River Dolphins as well as the world's only poisonous bird and the world's rarest underground roosting bird, it is a very special place. Therefore, it is important that the resources of the Kikori River Basin environment be protected for its present and future generations.

Apart from the animals, Kikori River Basin is also home to some special plant species. These plants are special to the local people as they use them for various purposes. Some examples include sago palms, mangrove cedar or cannonball mangrove, orchid such as grand dendrobium (*Dendrobium specabile*) and the digaso oil tree (*Camptosperma brevipetiolata*).

LESSON 15A – Junior Primary

Name of Lesson: Saving Special Animals of Kikori River Basin.

Objective: By the end of this lesson, students can:

- Identify at least three special animals of the Kikori River Basin
- Define "Conservation".
- Recognise the importance of conserving special animals of Kikori River Basin

Key Knowledge:

1. There are many special animals found in the Kikori River Basin.
2. To conserve is to set aside a resource for later use.
3. The special animals of Kikori River Basin must be conserved for future.

Materials Needed: Pictures and posters of the animals of the Kikori River Basin, student worksheets and information sheets.

Preparation: Help your students to learn about several animal species in the Kikori River Basin. If one or more of these species lives near your school environment, then organise a field visit to this site during class time. Use posters, information and facts sheets or other resources to carry out suggested activities.

Activity: Exploring Special Animals - Begin the lesson by showing them pictures of three flagship species of the Kikori River Basin i.e. Pignose Turtle, Tree Kangaroo and Inshore River Dolphin. Ask them if they have seen or heard of any of these animals. Make notes of the children's responses on the board. Tell them that in this lesson, they will learn more about one of these special animals – the Pignose Turtle. Read the short story about the Pignose Turtle or Piku on the *Activity Sheet 3.3*.

Discuss the following questions after reading about Piku:

- (i) What is a special thing the about Pignose Turtle?
- (ii) Where does it live? What does it eat?
- (iii) Who is its biggest threat?
- (iv) How can we help the Pignose Turtle?

Evaluation/Homework: Tell the class that the Pignose Turtle is a very unique animal of the Kikori River Basin. It must be protected before it is finished. For homework, students can draw pictures of the animal and colour it.

Student Worksheet 3.3~ Special Animal ~ Pignose Turtle

Read the story about Piku and learn about this special animal of the Kikori River Basin.

Hello boys and girls!

My name is Piku. I am a Pignose Turtle. Yes, I am a turtle but my nose is like a pig's nose. I also have feet called flippers like sea turtles.

I only live in Northern Australia and Southern New Guinea. You can find me in the waters around the Fly and Kikori Rivers. I eat different kinds of plants and animals. This includes fruits and leaves of fig. I also eat small water animals and insects.

I live for up to 18 years before I lay eggs. At the end of the dry season, I lay my eggs in the sandy beaches. My life and those of my family has been threatened by people. Our population is decreasing. If you do not help us now, we will all be gone by the time you grow up to be an adult.



LESSON 15B – Junior Primary

Name of Lesson: Saving Special Plants of Kikori River Basin.

Objective: By the end of this lesson, students can:

- Identify three special plants of the Kikori River Basin
- Recognise the importance of conserving special plants of Kikori River Basin

Key Knowledge:

1. There are many special plants found in the Kikori River Basin.
2. The plants of Kikori River Basin must be conserved for future

Materials Needed: Pictures and posters of the special plants of the Kikori River Basin, student worksheets and information sheets.

Preparation: Help your students to learn about special plant species in the Kikori River Basin. If one or more of these species is near your school environment, then organise a field visit to this site during class time. Use posters, information and facts sheets or other resources to carry out suggested activities.

Activity: Exploring Special Plants - Begin the lesson by taking the class outside for 10-15 minutes to look around the school environment. Return to the classroom and ask each group to name at least one special plant they saw. Ask each group to also say why they think this plant is special. Write the children's responses on the blackboard.

Now show them pictures of special plant species of the Kikori River Basin i.e. palm sago, digaso (*Camposperma brevipetiolata*), cedar mangrove (cannonball mangrove) and grand dendrobium orchid (*Dendrobium specia*). Ask the class to discuss why each of these plants is special to Kikori River Basin. Have each group share their responses with the whole class. Make a summary of the children's responses on the board. For example:

NAME OF PLANT	IMPORTANCE
Sago Palm	The core of flesh in the trunk is beaten and pounded into flour for use as food; harder trunks are used for flooring and walls, leaves for roof thatches, seeds for decorations,
Mangrove Cedar or cannonball mangrove	Strong wood for building houses
Grand dendrobium Orchid	Used for beatification
Digaso or oil tree	For extracting traditional oil

Evaluation/Homework: Tell the class that there many special plants in the Kikori River Basin. These plants must be protected. For homework, students can draw pictures of the plants and colour them.

LESSON 16A – Senior Primary

Name of Lesson: Conserving Plants and Animals of Kikori River Basin.

Objective: By the end of this lesson, students can:

- Define Conservation and Nature.
- Explain that Nature has a way of maintaining itself.
- State that resources of Kikori River Basin must be conserved.

Key Knowledge:

1. Conservation is the setting aside of a resource or asset for later use.
2. Kikori River Basin has unique forest and wetland habitats that must be protected.
3. The special plants and animals of the Kikori River Basin must be conserved.

Materials Needed: Pictures and posters of the plants and animals of the Kikori River Basin, student worksheets and information sheets.

Preparation: This activity may take up to two lessons. First, help your students to learn about several species in the Kikori River Basin. Second, give them the opportunity to create awareness on these species through posters, brochures and leaflets. If one or more of these species live near your school environment, then organise a field visit to this site during class time. Use posters, information and facts sheets or other resources to carry out suggested activities.

Activity: Taking Conservation Action – To begin the lesson, put up flash cards with the following terms on four corners of the classroom – *A. BROCHURE, B. POSTER, C. FACTSHEET and D. ALL OF THE MENTIONED.*

Tell the class that they are going to represent the special plants and animals of Kikori River Basin. Explain that as the teacher calls out a name of a special species (e.g. Pignose Turtle), each student should choose a method through which they think the awareness for this species should be made i.e. through methods A, B, C or D above. The student should then go and stand beside this labelled flash card. Keep playing the game for a few minutes. Then call the class to a halt to begin the discussion.

Explain to the class that creating awareness to the public about a special or important species is one of the best ways to help protect and conserve these plants and animals. Explain what each of the above methods is. That is:

1. *Brochure* is an informative paper document that helps to extend the reader's knowledge on one specific topic.
2. *Factsheet* may convey new facts or information or reinforce knowledge about a specific topic.
3. *Poster* promotes ideas where textual and graphic information is used. This should be both eye catching and informative.

Now divide students into six groups. Allocate each group with one of the special species. Ask each group to design a brochure, factsheet or poster to create awareness on the species allocated to them. Students can work on this as an assessable task. For example:



Evaluation/Homework: Remind students that the special plants and animals of the Kikori River Basin must be protected with their environment for future generations to see and appreciate. For homework, students can complete their posters. These can be used for school and community awareness.

Assessment Activity: This is an assessable activity. You can assess students based on criteria. For example:

- | | |
|--|-----------|
| (i) Completed poster/brochure/factsheet with clear topic/title | - 3 marks |
| (ii) Clear message and pictures | - 4 marks |
| (iii) Impression on neatness and presentation | - 3 marks |

LESSON 16B – Senior Primary

Name of Lesson: Conserving Biodiversity.

Objective: By the end of this lesson, students can:

- State that conservation is important for protecting the biodiversity of Kikori River Basin.
- Explain that nature conservation requires the effort of everybody.
- State that law must be enforced to strengthen biodiversity conservation efforts.

Key Knowledge:

1. Nature has its own means and ways of maintaining itself.
2. Nature must be protected by law.
3. Resources of the Kikori River Basin environment must be conserved.

Materials Needed: Pictures and posters of the plants and animals of the Kikori River Basin, student worksheets and information sheets.

Preparation: This activity may take up to two lessons. Use posters, information and facts sheets or other resources to discuss the biodiversity of Kikori River Basin. Help students to identify four or five unique species from KRB and carry out the activities.


Activity: Conserving Endangered Species - Begin the class by asking students to name plants and animals they think are special to the Kikori River Basin. Ask them to also explain why they think these plants and animals are special. Make a list of these points on the blackboard. These can be presented in a table like the one below:

NAME OS SPECIES	STATUS (<i>endemic, endangered, common</i>)
Pignose turtle	Endangered and endemic
Giant Woolly Rat	Endangered and endemic
Doria's Tree kangaroo	Endangered
Kutubu Rainbow fish	Endemic
Bird of Paradise	Common

Explain to students that some species like the Pignose Turtle and Inshore River Dolphins are unique to the Kikori River Basin and need to be protected. Ask students to suggest how these special plants and animals can be protected. Make note of students' suggestions on the blackboard.

Explain to students that since many of the species identified in the KRB are rare, threatened and endangered; there is a need to protect them. Some ways species can be protected are:

- Creating awareness on the importance of these species.
- Protecting their habitats by laws such as Conservation Areas Act or Fauna Protection (and Control) Act.
- Setting aside Conservation Areas or Wildlife Management Areas to protect them.



Ask each group to choose one of these species. Then write a cinquain style poem expressing how they feel about it. *Cinquain style poem is a type of poem that uses nouns, adjectives, verbs and synonyms to describe a subject.* For example:

- Choose one or two words to name the subject you are writing about.

Poisonous Pitohui

- Use two words (adjectives) to describe it.

Orange, black

- Use three words (verbs) to describe what it might be doing.

Flying, roosting, feeding

- Use a four word phrase to tell how you feel about it.

Moving dangerously and quickly,

- Use another word (synonym) that means the same as the subject.

Bird

Task each group to write up a factsheet about the species they have written the poem about. They can use this to create awareness in the school and their local community.

Tell the students that conservation of the unique plants and animals of the Kikori River Basin are important for the present and future generation. They are also the world's treasures and need to be protected. We all have a responsibility to make sure that these unique treasures are conserved.

Evaluation/Homework: Students will complete their factsheets for homework. These can be used to give a talk to the whole school during morning assembly.

Assessment activity: Students can be assessed on the following criteria:

- | | |
|---|-----------|
| (i) Group work | ~ 2 marks |
| (ii) Facts are accurate and clearly written | ~ 3 marks |
| (iii) Illustration of species provided | ~ 3 marks |
| (iv) Neat presentation | ~ 2 marks |

UNIT 4: CLIMATE CHANGE



GLOBAL WARMING Causes CLIMATE CHANGE

Introduction

Climate and *weather* are related words. Weather means temperature, air pressure, humidity, precipitation (rain or snow), sunshine, warm or hot, cloudiness or fog, thunder, ocean temperatures and winds. *Weather refers to the daily climatic conditions at one particular time and place.* The weather changes every minute, hour or day and they are measured and recorded at the weather stations to produce weather patterns after a period of time. Climate is *weather patterns* generated after many years of collecting weather information. *Climate refers to the long-term average pattern of weather in a place.* Climate has always changed naturally and gradually over very long periods of time.

Scientists have warned that the world's climate has changed a lot, and has affected many living and non-living things. Many places that were warmer are now getting colder, and many colder regions are getting much colder or even warmer.

TOPIC 1: CAUSES AND EFFECTS OF CLIMATE CHANGE



Diagram 5 Illustration showing the Sun warming the colder regions while there is rain in dry hotter areas on earth

1. What is Climate Change?

Climate change is a long term change in the weather patterns. For example, the change in temperature, rainfall and wind experienced by an area or region. In the months of April to June is the rainy season in Kikori River Basin but if climate change affects it, these months would experience drought instead of rain. Climate change represents a change in these long-term weather patterns. They can cause the warming or cooling of the Earth's temperature.

The Earth's climate has changed over the last century. Increases in average temperatures have been seen around the globe and there is new and stronger evidence that most of the warming observed in the last 50 years is due to human activities. While climate change is a global issue, it will affect us all. Climate change has the potential to adversely affect our environment; our communities and our economy unless we take action now to reduce our greenhouse gas emissions and prepare for the impacts. It will alter global and local climates, and this means a warmer and drier future, with an increasing likelihood of more extreme events such as heat waves, prolonged dry season and associate effects such as bushfires and storm surges.

2. Climate Change is Happening!

The evidence is clear – rising global temperatures have been accompanied by changes in weather and climate. Many places have seen changes in rainfall, resulting in more floods, intense rain, droughts as well as frequent and severe heatwaves.

Climate change is the overall change in our environment and results from the continuous pollution (CO₂ emission) released from large scale land developments such as logging, agriculture, mining, wharves, city expansions, and factories and traffic. All these human activities produce carbon dioxide (CO₂) gas which builds up in the Earth's atmosphere and are

sent back to heat the Earth. The increased heat being sent back to Earth is causing change in weather patterns which have a strong impact on the environment and the people.

3. Climate Change Facts

These are facts and are not in dispute:

1. The earth is warming.
2. Climate has always changed – but never this rapidly in human history.
3. Today's warming is mainly due to emissions from fossil fuels.
4. Sea levels are rising.
5. The Arctic is melting.
6. The oceans are becoming more acidic.
7. Weather events are becoming more intense and frequent.
8. Small changes in temperature have immense consequences.
9. Climate change will impact people in many ways.

4. What Causes Climate Change?

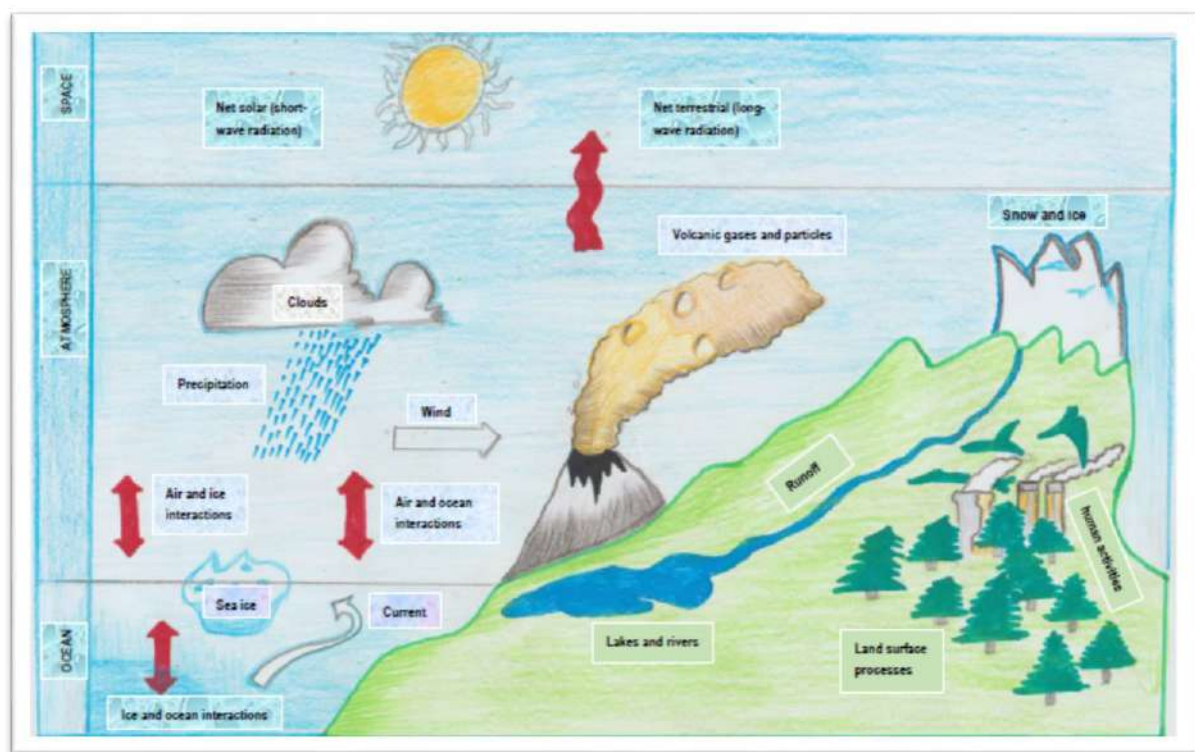


Diagram 6 Illustration of Climate Variation Factors

Over the past century, human activities have released large amounts of excess carbon dioxide (CO₂) and other greenhouse gases into the Earth's atmosphere. Water vapor and carbon dioxide are the common examples of greenhouse gases. Other greenhouse gases include methane, nitrous oxide and chlorofluorocarbons. The majority of greenhouse gases come from burning fossil fuels to produce energy. Some of these are also produced by factories, cutting

down trees, and some agricultural practices like garden fires. These activities have contributed to a release of large quantities of greenhouse gases into the Earth's atmosphere where they stay trapped in the Earth's atmosphere. As these gases or carbon emissions build up, they heat up the atmosphere resulting in global warming, which in turn alter the Earth's climate patterns and causing climate change.

5. The Natural and Enhanced Greenhouse Effect

About half of the Sun's energy reaching the top of our atmosphere penetrates to the Earth's surface as short wave radiation. The rest is either reflected back into the space by the atmosphere or absorbed by gases and dust particles. The solar energy that does reach the Earth's surface warms the land and oceans. In turn, the land and oceans release heat in the form of infrared radiation or long wave radiation. Greenhouse gases absorb some of this radiation, acting like a blanket and keeping the planet warm enough to sustain life. This is called the ***natural greenhouse effect*** and is illustrated in Figure 24 below.

However, human activities, predominately the burning of fossil fuels, intensive agriculture and land clearing, are causing greenhouse gas build up in the lower atmosphere to rise above natural levels. In effect, the Earth's blanket (atmosphere) is becoming thicker, trapping extra heat and further warming the planet. This is called the ***enhanced greenhouse effect***.

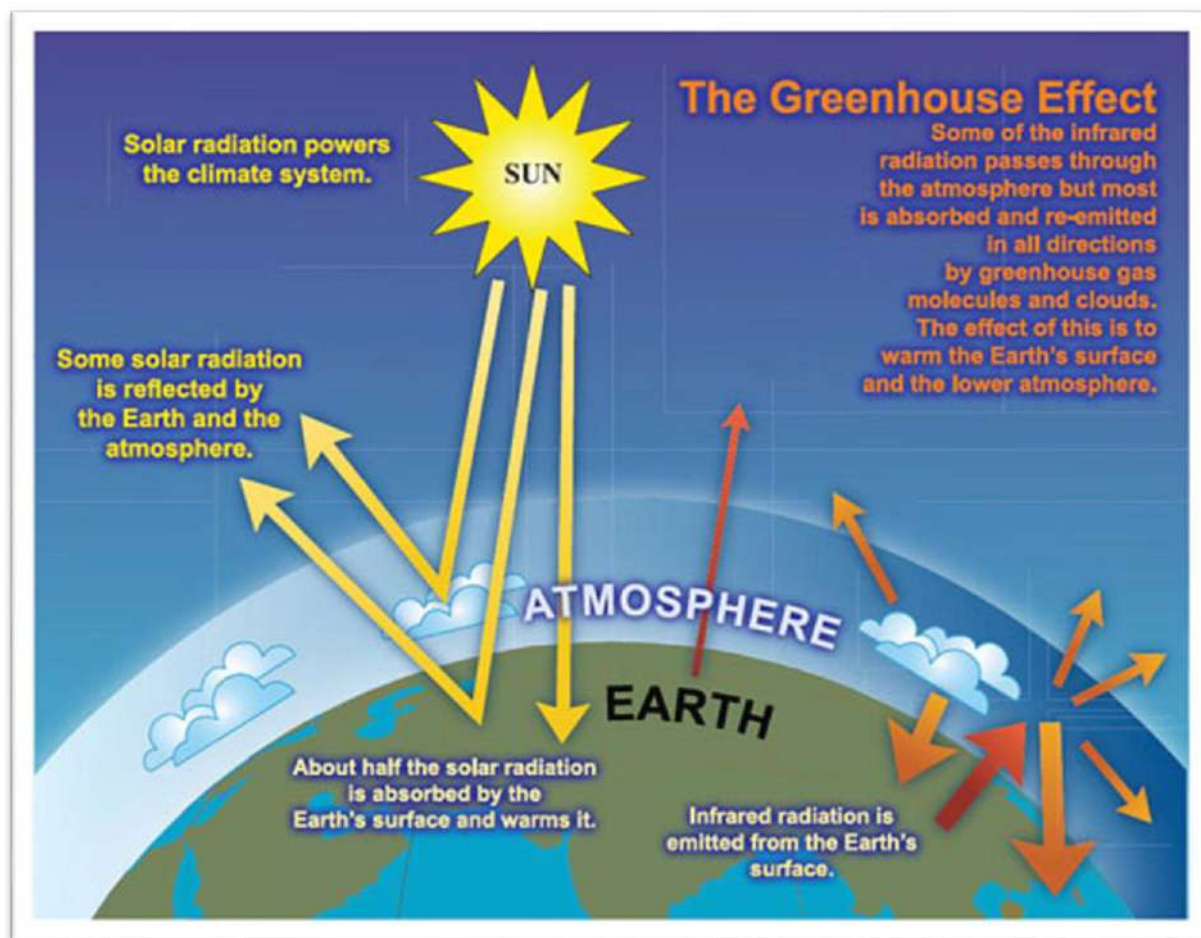


Fig. 23 Illustration of the Green House Effect

The more carbon dioxide and other greenhouse gases are released, the more they get trapped, and the more heated our atmosphere becomes. As a result, the average global temperature rises which will lead to other changes in weather. The warming of the earth's temperature is called **global warming**.

Global warming is a situation in which the earth's surface is warming up due to an increase in greenhouse gases (such as carbon dioxide or CO₂) in the earth's atmosphere, trapping more heat and sending it back to the Earth.

Storm patterns and severity might increase, sea levels will rise, and floods and drought may become more frequent and more severe.

Some changes to the climate are unavoidable – even if we stop emitting greenhouse gases now, the gases have already been released and will have an effect. However, we must do everything we can to avoid further changes, and to adapt to the impacts of climate change.

Critical risks include:

- Sea level rise
- Ocean acidification (when carbon dioxide reacts with water to create carbonic acid)
- Severe recurring droughts and drying trends
- Increase in extreme weather events such as heat waves, bushfires and floods

Current estimates show that global warming is greater now than was reported in 2007 (IPCC, 2007). Small increases in average temperature could lead to impacts on human wellbeing in the future.

6. Climate Change Impacts



Fig. 24 Malaria Penetration into the Highlands because of Climate Change.

The climate change impacts are seen all over the earth - around the world. Many people in Papua New Guinea today are vulnerable to the changes of the natural environment due to climate change. Climate change is already having observable effects on the environment and human lives in many parts of PNG. Increased strength of the heat produced, heavy downpours, droughts, regular landslips and regular flooding challenge many aspects of life. Furthermore, roads and bridges, farmlands, sustainable livelihoods of communities and ecosystems are increasingly challenged by these changes. More adverse impacts from climate change are expected to come.

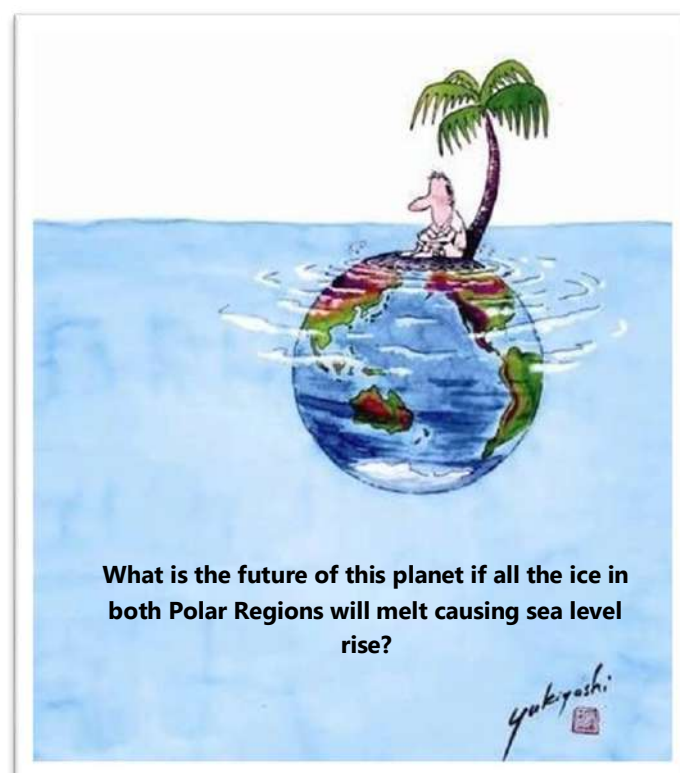


Diagram 7 Artist impressions of unknown future climate change events.

7. Expected Future Threats from Climate Change

Scientists have high confidence that global temperatures will continue to rise for decades to come, largely due to greenhouse gases produced by human activities. The following are impacts to be expected in the near future or even today:

- Extreme weather will become more frequent and more dangerous.
- A surge in wildfires - Hot, dry conditions due to long dry seasons will create wildfires.
- Increased or intense rain.
- Increased drought.
- More intense cyclones – Cyclone intensity could increase and associated storm surge.
- Threats to human health - Spreading insect-borne diseases and respiratory illnesses.
- Devastating heat waves - Extreme heat.

- Spread of disease - Diseases such as malaria and dengue fever could become more difficult to control.
- Worsening air quality - More smoke pollution.

8. Climate Change Impacts and Adaptation

The changing climate impacts society and ecosystems in a broad variety of ways. For example, climate change can increase rainfall, influence agricultural crop yields, affect human health, cause changes to forests and other ecosystems, or have an impact on our energy supply. Climate-related issues are occurring across regions of the country and across many sectors of our economy.

Many state and local governments are already preparing for climate change through “adaptation” projects. In PNG, the Climate Change Development Authority (CCDA) is the government department responsible for dealing with climate change and climate change impacts and adaptation. They make climate change policies to control human activities, especially industries practices, and talk with other governments around the world to share information and ideas to guide the climate change impacts adaptation work in each country.

Some of the ways in which PNG CCDA works with different organisations to support climate change adaptation work in our country are;

- Reforestation – Planting trees.
- Coastal mangrove ecosystem rehabilitation.
- Agriculture food crop research to ensure the food crops is drought resistant.
- Control land use practices in agriculture and forestry, mining, oil & gas and fisheries projects.
- Invest in clean energy such as hydro-power, solar energy, or alternative energy sources.

We can help PNG CCDA in supporting climate change adaptation projects in many ways at national, provincial, district, local level governments and in our villages and homes by participating in various climate change adaptation works. Even at individual level we can make personal decisions to adapt to climate change by:

- Installing solar power in our homes.
- Planting trees in our old gardens.
- Make laws in our community not to cut trees, make fire or burn the bush, or even how we extract resources from our forest and mangroves and rivers and lakes systems.
- Reducing consumption of processed goods or making wise decisions on how we use resources to save energy, reduce carbon dioxide and resulting greenhouse effect.

LESSON 17A – Junior Primary *(Recommended for Grade 5)*

Name of Lesson: The Earth's Climate is Changing.

Objective: By the end of this lesson, students can:

- State that the Earth's climate is changing.
- Identify changes in the environment caused by the changing climate.

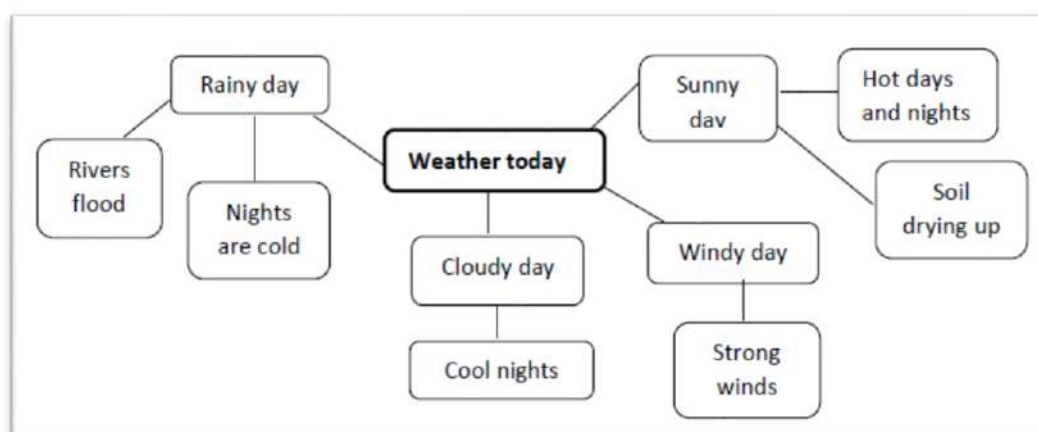
Key concepts:

1. The Earth's climate is changing.
2. Changes in the Earth's climate can change weather patterns.
3. Plants, animals and people can be affected by changes in the weather.

Materials Needed: Pictures, charts and or posters of weather conditions and changes in the environment caused by changes in weather such as floods.

Preparation: Collect and display pictures of changing weather conditions such as lots of rain causing floods, long periods of dry season causing droughts, strong winds causing trees and houses to fall, and so on. It is advisable to have your students work in groups as they will be discussing and deciding on their responses to the activity. You may also prepare a weather chart or poster showing different weather conditions.

Activity: Recording Weather - Begin the activity by brainstorming on the day's weather. Probe the class to share their thoughts on what they think can happen during such weather. Make note of these on the blackboard. For example:



Tell the class that weather is the day to day condition of a place at a particular time. For example, sunshine, temperature, rainfall, wind condition, cloud condition and so on. Similarly, climate is the long term average weather pattern of a particular place.

Inform the class that for this lesson, they will work in groups of 4 or 5 to start recording the weather conditions for the next three days. The weather should be recorded at the same time every morning (i.e. 8:00 o'clock). Put up the following chart for the groups to copy and complete.

My Weather Chart

Day and Date	Time	Cloud Condition	Wind Condition	Prediction about the day's Weather
<u>DAY 1</u>				
<u>DAY 2</u>				
<u>DAY 3</u>				

After the third day, have the class discuss their observations. Ask them to talk about whether their weather predictions were correct. If not, why? *Allow students to give their opinions about what is happening.*

Explain that the day to day weather conditions are not very predictable these days. There seem to be a lot of changes in the weather conditions as well as the climate of a place. One of the reasons is that scientists think the climate is changing a lot faster than in the past. This they say is affecting plants, animals, people and the environment.

Evaluation/Homework: Remind students that weather predictions are not very reliable these days because of the changing climate. For homework, ask students to make a list of three (3) things that can happen to plants and animals when the climate changes. Discuss these in the next lesson.



LESSON 17B – Junior Primary

Name of Lesson: Changes caused by Earth's Changing Climate.

Objective: By the end of this lesson, students can:

- Identify changes in the environment caused by Earth's changing climate.
- Make a list of natural disasters caused by the changing climate.

Key Knowledge:

1. Changes in the Earth's climate are causing changes in the environment.
2. Natural disasters increase as Earth's climate changes.
3. Plants, animals and people can be affected by natural disasters.

Materials Needed: Pictures, charts and or posters of changing weather conditions and natural disasters such as floods.

Preparation: Collect and display pictures of natural disasters such as flooding, droughts, strong winds and cyclones.

Activity: Discussion – Begin the lesson by asking students to share stories about events that happened in their environment where people's lives were threatened. Allow 3-5 minutes for a few students to share their experiences. Based on these stories, ask students to name few of these events and list them on the board. For example, flooding rivers and streams; landslides or mudslides on the mountains; drought; bush fires caused by drought; and earthquakes.

Ask students to give examples of the events they think are caused by changes in the Earth's climate. Students can give their opinions which should include flooding, land and mudslides, and drought. Explain that many of these events are often referred to as natural disasters.

Tell them that scientists think that natural disasters are increasing because Earth's climate is changing at a faster rate. As this happens, the environment is affected because it also changes. This means plants and animals are also affected.

Evaluation/Homework: Emphasise to the students that changes that are happening in the environment are caused by the changes in the Earth's climate. For homework activity, students can choose one natural event related to climate change and draw pictures of what they think can happen to people, plants and animals during that event. This can be discussed in the next lesson.

LESSON 18A – Senior Primary

Name of Lesson: Climate Change.

Objective: By the end of this lesson, students can:

- Differentiate between weather and climate.
- Define "Climate Change".
- Describe the changes caused by Earth's changing climate.

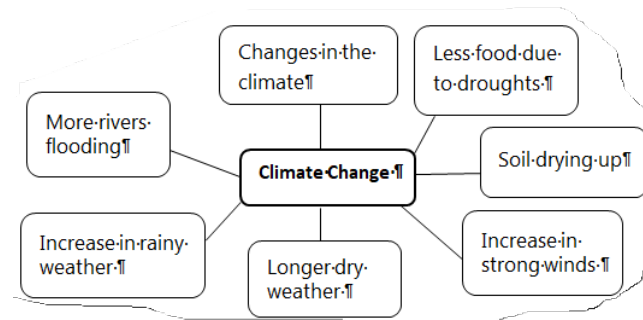
Key Knowledge:

1. Climate change is a long term change in weather patterns of an area.
2. Changes in the Earth's climate can affect plants and animals.
3. Human activities can cause changes in the Earth's climate.
4. Humans can take action to minimise the impact of climate change.

Materials Needed: Pictures, charts and/or posters on climate change.

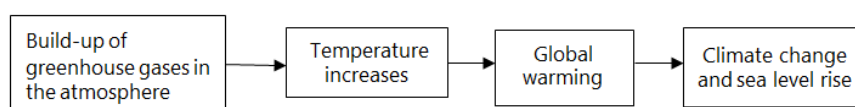
Preparation: Two days before the actual lesson, prepare your chart or poster similar to the Activity Sheet on *page 115*. Organise your students to work in small discussion groups.

Activity: Discussion on Climate Change - Begin with a brainstorming activity. Ask the class to talk about what they think climate change is and what causes it. Make note of their views on the blackboard. For example:



Put up the poster on what is climate change, its causes and effects on people and environment. See sample poster at the bottom of *page 115*. Ask the class to study and discuss the poster.

Explain that climate change is a change in the weather patterns experienced in an area over a period of time. Changes in the climate are caused by the build-up of greenhouse gases such as carbon dioxide in the atmosphere, causing it to heat up. This causes the temperature to increase, resulting in the earth becoming warmer. The warming of the earth is called *global warming*. Global warming causes changes to climatic conditions of different areas such as temperature, wind, rainfall, etc. These changes are referred to as *climate change*. Global warming also results in sea level rise. That is:



Divide the class into four groups. Explain that they are going to perform a role play showing what happens in different situations if there are changes in the climate. The groups are as follows:

Group 1 – Plants and other vegetation

Group 2 – Birds and other animals

Group 3 – Local/village people

Group 4 – Farmers, hunters and fishermen

Groups will take the role of each of the groups they represent. Then they will perform these role plays. While one group performs their role play, the rest watch and respond to any questions they ask.

Discuss the role plays. Ask the class to talk about what they saw in each play. Explain that, all members of a living community will be greatly affected when the climate changes. It is therefore, important that humans must take actions to protect the environment from the effects of the changing climate.

Evaluation/Homework: Remind the students that humans can play a key role in reducing the effect of climate change. For homework, students can suggest several actions that humans can take to address climate change.

Sample poster on climate change

CLIMATE CHANGE

What is it?
A long term change in the weather patterns such as temperature, rainfall, and wind experienced in an area.


Why is it happening?
Because industry and ordinary people are releasing large amounts of climate change gases such as carbon dioxide and water vapour. These gases trap and release heat back into the air. Some of these are also produced by factories, cutting down trees, and agricultural practices like garden fires.
When the atmosphere heats, the temperature becomes warmer resulting in global warming. This in turn alter the Earth's climate patterns, causing climate change.

Its Impacts.....
Some areas are becoming wetter with more storms, floods, and landslides, while other areas are becoming hotter and drier. Furthermore, roads and bridges, farmlands, sustainable

livelihoods of communities and ecosystems are increasingly challenged by these changes.

Ways to address these.....
People can takes actions such as reforestation, or improve the food supply. For example:

- Developing drought resistant crops.
- Building sea walls and flood barriers.
- Planting mangroves on coastlines and estuaries and lagoons.
- Use alternate energy sources such as solar panels or wind-mills.
- Choosing tree species and forestry practices that are less vulnerable to storms and fires.
- Set aside land corridors to help species migrate.





TOPIC 2: TAKING ACTION

1. How can we address effects of Climate Change?

The effects of climate change can be addressed through adaptation and mitigation measures.

2. Adaptation to Climate Change

Adaptation means *anticipating the adverse effects of climate change and taking appropriate action to prevent or minimise the damage they can cause, or taking advantage of opportunities that may arise*. It has been shown that well planned, early adaptation action saves money and lives later.

These adjustments can be protective against negative impacts such as reforestation, or opportunistic like improved food supply which takes advantage of the beneficial effects. For example:

- Developing drought resistant crops.
- Building sea walls and flood barriers.
- Planting mangroves on coastlines and estuaries and lagoons.
- Alternate energy sources, solar panels, windmills, etc.
- Choosing tree species and forestry practices less vulnerable to storms and fires and setting aside land corridors to help species migrate.

Adaptation strategies are needed at all levels of administration: at the local, regional and national level. Due to the varying severity and nature of climate change impacts felt across the world and PNG, most adaptation initiatives should be taken at the regional or local levels. The ability to cope and adapt also differs across populations, economic sectors and regions.

3. Reforestation

Replant trees on deforested areas and along the river banks. This will help provide nutrients and hold the soil intact. The trees will provide homes to the birds and wildlife and clean water during long dry periods. Trees will also take in carbon dioxide. Also, plant fruit trees like oranges for fruits.

4. Water Resources

Improve efficiency of water use and build additional storage tanks to increase capacity. Protect and restore stream and river water by planting trees along banks. This will enrich the water quality.

5. Agriculture and Food Supply

Plant crop varieties such as banana and taro that are more tolerant to heat, drought and water logging from heavy rainfall or flooding. Furthermore, visit your local Department of Agriculture office to seek assistance and advice.

6. Mitigation

Climate mitigation is any action taken to prevent or reduce the emission of greenhouse gases. Some ways in doing that is decreasing human induced activities that threatened our natural forests. For example, avoid bush burning or use solar or hydro power instead of diesel generated power.

7. Climate Change Adaptation Initiative in PNG

Many people in Papua New Guinea today are vulnerable to the changes of the natural environment. Coastal flooding, inland flooding, landslides and droughts take a severe toll on the people and the economy. Climate change will likely exacerbate some of these event-driven hazards and may also introduce new hazards due to gradual shifts in climatic conditions – most prominently, further malaria penetration into the highlands, changed agricultural yields and damaged coral reefs.

Therefore, the Climate Change & Development Authority (CCDA) has taken the lead to implement specific adaptive measures identified through a five step risk management methodology. This strategy will be applied to each sector, such as the agriculture, fisheries, extractive industries, and critical infrastructure areas.

In agriculture, land management techniques are ongoing issues with challenges of fostering crop diversification. Furthermore, there are issues of changing traditional crop calendar with problems arising from water availability and usage. Effective management of pest, diseases and weeds are current focus and need to be up-scaled coupled with the development and use of crop varieties resistant to pest and diseases.

In fisheries, there is a need to diversify and re-adjust fishing practices and encourage viable options to maintain fisheries productivity. There is also a need to identify most practical and profitable fishing options mixed with selective usage of adaptive fishing gear and baits that can exclude unwanted and attract desired species.



Fig 25 Nursery in Kavailo Bay, Karkar Is Madang. Photo; Kyaro@WWF PNG/2015

LESSON 19A – Junior Primary

Name of Lesson: Taking Actions: Preparing for School Awareness.

Objective: By the end of this lesson, students can:

- Plan a whole school awareness activity to help students and teachers understand the impact of climate change.

Key Knowledge:

1. Climate change has an impact on people and environment.
2. People must be aware of their role in protecting the environment.

Materials Needed: Exercise books, pen/pencils, rulers, butcher or cartridge papers and any other materials required by different groups.

Preparation: Students will be working in groups so organise your students to delegate specific task to each of their group to do. They must also choose a group leader to take charge of their group work.

Activity: School Awareness Preparation - Begin the activity by asking the class to share what they recalled about the impact of climate change on the environment and people. Make a list of this on the blackboard.

Explain to the class that they are going to make awareness to the whole school during an outdoor assembly. They will focus on four (4) key areas. These are:

- a. What climate change is?
- b. What causes it?
- c. Impact of climate change on plants, animals, people and the environment.
- d. What people can do to reduce the impact?

Divide the class equally into four (4) groups. Allocate each group with the key point they will talk about. For example:

- | | |
|--------------------------|---------------------------|
| (i) Group 1 - Point (a) | (iii) Group 3 - Point (c) |
| (ii) Group 2 - Point (b) | (iv) Group 4 - Point (d) |

Have each group prepare the key points using different methods. One group will memorise the key points and recite them during the assembly. The second group will prepare posters and use this to give their talk. The third group will prepare poems and read them. The fourth group will perform a short play to share their messages. Make sure that no two groups use the same approach to deliver their messages. Help each group to choose their approach of delivery. Then assist them to prepare their materials, costumes, etc.

Evaluation/Homework: Remind the class that climate change is a global environmental issue. It requires the efforts of all citizens of a nation to address this in a big way.

Assessment Activity: Assess the group during and after the activity. The assessment is both informative and summative therefore many different ways can be used to assess this activity.

LESSON 19B – Junior Primary

Name of Lesson: Taking Action: Whole School Awareness Assembly

Objective: By the end of this lesson, students can:

- Share and create awareness on how to help the whole school understand the impact of climate change on their environment.
- Take simple practical actions to protect their environments against the impact of climate change.

Key Knowledge:

1. Take simple actions to minimise the threats on the environment.
2. Plant more trees in degraded environments to help stop soil erosion.
3. Make people aware of their roles in protecting the environment.

Materials Needed: Recycled food packets, example: milk, rice, etc. used tinned fish and Sunshine milk tins or poly bags, tree seedlings (mangrove, rosewood, fruits, palms, etc.), butcher or cartridge papers and any other materials required by different groups.

Preparation: Collection of materials should begin at least a week before the actual activity. Each student should also bring at least two seedlings that they have planted in recycled food packets for distribution to other classes. Students will be working in groups organise your students to delegate specific task to each of their group to do. They must also choose a group leader to take charge of their group work.

Activity: Whole School Awareness Assembly: Begin the activity by ensuring that the class had prepared all their materials and costumes. Help each group to take all the materials and costumes to the assembly area. Help the class to also set up and decorate the assembly area in preparation for the awareness sessions.

Help to ensure all the students and teachers are at their designated spot at the assembly area. Allow the head teacher to proceed with all formalities before taking on as the master of ceremony. Have each group go up to the front to present their activity.

After assembly, the tree seedlings prepared one week in advance by the class can be distributed to each class in the school. These should then be planted around the school on selected sites. The planting of the trees by different classes should be witnessed by students in your class. *Note: Alternative approach would be to visit a nearest forestry or DPI station and talk to your forestry & agriculture extension officers to talk to teachers and students. Make arrangements for seedlings from the DPI nursery to be distributed to schools and facilitate planting trees.*

Evaluation/Homework: Remind the whole school that climate change is a global environmental issue and requires the efforts of all citizens of a nation to address this in a big way. School children can take small steps towards making the community aware of the issue and think about how they can help to reduce the impact. Thus, creating awareness through different approaches and planting tree seedlings are simple actions that children and the school can take to address climate change. As homework, the whole school can be given an essay competition to emphasise the message about tree planting.

LESSON 20A – Senior Primary

Name of Lesson: Taking Action – Building a Plant Nursery for Seedlings.

Objective: By the end of this lesson, students can:

- Build a simple temporary nursery using local resources available and raise plant seedlings for planting in school grounds and community for agro-forestry needs.
- Learn nursery skills, techniques and procedures in seed collection, propagation, and tree planting.
- Understand different planting sites and site preparations techniques, and field planting techniques.

Key Knowledge:


1. Climate change adaptation through plant nurseries and tree planting.
2. Trees are important in absorbing carbon dioxide gas and regulate temperature.
3. Planning, designing and implementing school-based projects for climate mitigation, conservation and for the rehabilitation of natural resources.

Materials Needed: *Tools & Equipment* – Bush knives, grass knives, spades, shovels, axes, digging stick, hammer, saw, exercise books, pen/pencils, rulers, tape measures, and student activity sheets. *Nursery shed house* – Timber, frons from sago palm or other palm trees, saplings, poles, ropes, and nails. *Nursery Beds* - Recycled food packets, example: milk, rice, etc. used tinned fish and sunshine milk tins, plastic container such as coke bottle, cans, compost (leave litter), collect hips of fine river sand, hips of forest soil, or poly bags, tree seeds or young seedlings (mangrove, rosewood, fruits, palms, etc.).

Preparation: This activity can take two or more lessons. It can be planned at least six months in advance as a whole school project so that it can coincide with the World Environment Day tree planting programme. The project can be discussed with head teachers and school board to gain support in some logistic planning. For example, purchase of nails, and organise school support staff to provide labour for helping school children to collect materials, prepare and build the nursery. It is also important to talk to the nearest forestry and agriculture officer for their extension support and providing training in forest nurseries or conducting awareness and talking to students.

Students can be advised to collect nursery materials and tools and equipment to build nursery shed house and nursery beds for seedling stand down. The actual construction can be done with the assistance of support staff and forestry & agriculture or NGO staff guidance. Students can be allocated in groups to participate in different activities of the nursery. Preferably, if the project is done as school project, then your class will need to implement this lesson on allocated class activity days. Divide your students into four work groups. Each group should choose a leader who will delegate tasks to each member.

Activity: Tree Planting Project - Discuss with the class the importance of addressing climate change using different approaches. Explain that planting trees is one way through which schools and their communities can take action. Draw on knowledge from previous lessons. You may have to prepare information on cards to make the discussion interesting. Involve all students by distributing the cards and letting them read out the information loudly to the class.



Explain the project and the importance of this activity for their community. Facilitate and guide the class discussion in the planning, designing and implementing of their class project. Students are to follow the instructions on their *Activity Sheet 4.1* for the school-based project.

Note: The seedlings in the nursery will require sufficient time to grow and harden off before field planting. This can take up to 6 months. Therefore, this project can be done early to give enough time for seedlings to mature. Students & support staff to ensure upkeep of nursery up to the time of planting, for example, on WED (June 5th). The teachers, students and school support staff can decide on appropriate site to plant.

Students must monitor the seedlings when in the nursery and also when they are planted. Their observations are to be recorded and presented at the end of each week to the class. They must also keep a journal for this project. *Note: Working groups can be allocated one nursery beds to tend, water, weed, and up keep nursery seedlings prior to planting. Marks can be awarded for best up keep and quality of seedlings raised and number of seedlings surviving.*

Students can compile their presentations and write a short report about the project. Their report may include illustrations, pictures and/or photographs. Choose the best report for the school bulletin/notice board.


Note:

- a. Make a decision on the timeframe of this project. Ensure that your students do awareness to the school and the community about their project.
- b. Integrate the awareness activity on the project with lessons in subjects, for example Social Science, Science, Mathematics, Arts and Language. Activities in the School Clubs Handbook may give you some more ideas. For example, a drama or play about the environment, public forum, quiz, etc.
- c. Prepare a roster for the class to monitor the trees weekly. This can be done in pairs or groups. The monitoring activity on their project work will also enable students to acquire more knowledge, skills and attitudes about the importance of the impacts of climate change on their community.
- d. Encourage and re-enforce observation, recording and reporting in doing team work. These skills are important as information collected emphasises the key concepts and knowledge of the subject matter.
- e. The project activity is assessable and can cover relevant learning objectives in the above mentioned subjects. Make sure you develop a marking instruction that is specific and manageable for your assessment.

Evaluation/Homework: Ensure that all groups have participated in constructing their nursery and have placed their tree seedlings in the nursery. For homework, ensure that these seedlings are watered.

Assessment Activity: The project activity can be assessed during and after the activity. The assessment is both informative and summative therefore you have many different ways to assess this activity.

Activity Sheet 4.1 ~ Planning Your Nursery for Tree Seedlings



The following set of instructions will help you to set up your tree planting project as a class.

What to do:

1. You will need materials such as bamboos or timber from trees, banana, coconut or sago palm leaves or green netting from the hardware shop, nail or ropes, and any other used materials.
 2. Discuss, plan and design the shelter or area where your project will be carried out.
 3. Identify and name the tasks to be carried out. Organise yourselves into groups in order to carry out these tasks. Each member will be responsible for a certain task. Don't forget to appoint a leader for your group.
 4. Carry out your task in your own groups as planned. Your group leader will make sure you complete your task on time. Take note of the following:
 - Construct your nursery near a water source as this will enable sufficient supply of water for your seedlings.
 - Collect polybags or recycled food packets. Empty rice, milk and sugar packets are useful for this task. Empty tins such as tinned fish and sunshine milk tins are also useful.
 - Prepare your soil in the bags/containers or whichever material you are using.
 - Seeds can be planted directly into the prepared bags/containers. Proper care has to be taken to germinate the seeds and then transfer the seedlings into the prepared bags/containers. These can be stored until they are ready to be planted.
 - Plant the seedlings in the allocated areas. Ensure that seedlings are firmly planted so that they are not easily uprooted by animals.
 5. Follow the roster your teacher has drawn up in order to monitor the tree seedlings. You may have to do this as a group.
 6. Record your observations at the end of each week. Here are some general questions to help you record and report your observations:
 - a) If you have sown the seeds, then record when it started to germinate, and date when all germination is completed.
 - b) If you transplanted the young seedlings from the forest floor into the poly bag or container, then are there any new leaves growing on the plants?
 - c) Are the plants getting taller? Measure the initial height of seedlings before transplanting or when first germination starts. Keep recording the height of seedlings
 - d) Are there any small animals living on the plants? Insects? Do they attack seedlings? Record number affected. Remove the insect or apply home-made insecticide (Tobacco soaked in 15 Litre water and kept overnight, strained with strainer, Mix detergent with tobacco soaked water and apply on seedlings to kill or reduce insect attacks)
 - e) Is the area around the plants free of rubbish? Keep the nursery area clean and regularly apply water on seedling beds.
 7. Give a verbal report on this observation for the class to note into their exercise books.
- Write a short concluding report on the above observations. Complete this short report as a group and include illustrations, pictures and/or photographs. Hand in your group's report to your teacher.

LESSON 20B – Senior Primary

Name of Lesson: Taking Action – Community Awareness.

Objective: By the end of this lesson, students can:

- Identify and implement simple practical activities to protect their environments against the impact of climate change.
- Make awareness to the community on the impact of climate change and the role of people in taking actions to reduce these impacts.

Key Knowledge:

1. Take actions to reduce the impact of climate change.
2. Plant more trees in different environments to help stop soil erosion.
3. Plant crop varieties that are more tolerant to heat, drought and water logging from heavy rainfall or flooding.


Materials Needed: Tree seedlings ready for distribution, seedlings of variety of crops and other materials needed.

Preparation: This activity will take two or more lessons to complete. Begin collecting the materials a day or two before the actual lesson. Make sure students are divided into four working groups as they will be discussing and deciding how to implement their activities. Students must also be organised to choose each member in their team to have a specific task to do. They must also choose a group leader to take charge of their group work.

Activity: Community Awareness - Discuss with the class on the importance of trees and their role in mitigating climate change, for example, trees absorb carbon dioxide and store as wood. Trees store the excess carbon in the form of wood; as such trees act as carbon sink. Therefore, informing the communities to plant more trees while at the same time retain those forest areas under protections such as community conservation areas or wildlife management areas is a positive contribution and a right attitude in investing community resources in an action to reduce the impact of climate change. Use the group reports on the previous lesson to reflect on the results of their observations. Allow the class to suggest various approaches they can use to inform their communities on the importance of tree planting to reduce the impact of climate change. Make notes on the blackboard.

Explain to the class that for this lesson, each group will prepare an activity or task for community awareness. That is, one group can produce pamphlets while another produces posters. The third group can write a proposal to the local level government about the importance of climate mitigation for their communities, and ask for funding or support for the school project for tree nursery or awareness activity. The fourth group can prepare and present a short play during community market day to reinforce the importance of the impact of climate change and the need for people to take action to reduce its effects.

Have the groups plan and design their activities in preparation for the community awareness. Invite the Ward Councillor and the Council President or Department of Agriculture or PNG Forest Authority or NGOs to attend the community awareness day where the proposal can be handed to them.



On the appointed day (this should be a day that all community members around the school gather at the school grounds like on the market day); each group can present what they have prepared including the proposal to the local level government.

At the end of the community awareness, tree seedlings prepared by students at their nursery can be distributed to the community members.

Teacher's Note:

- a. Make a decision on the timeframe for this activity.
- b. Ensure that the students do the community awareness during the school market day or P & C Day about the impact of climate change and the importance of the rehabilitation of trees.
- c. Invite the Ward Councillor and the Council President to attend the community awareness day to witness students' presentations as well as receive the proposal.
- d. Arrange with the local Forestry/Agriculture Officer to pick up tree seedlings that can also be distributed during the awareness day.

Evaluation/Homework: Reinforce the importance of rehabilitation of trees as a simple action to reduce the impact of climate change. For homework, ensure that tree seedlings in the nursery are watered.


Assessment Activity: The project activity can be assessed during and after the activity. The assessment is both informative and summative therefore you have many different ways to assess this activity.

UNIT 5: WASTE, POLLUTION AND EXPLOITATION



Introduction

Thousands of years ago, few people lived on the planet Earth. These people lived a nomadic life and had only basic things for survival such as clothing, simple shelters, tools and weapons. They left only a little waste and therefore, there was hardly any pollution of their environment. As more people were born, villages, towns and cities were created and began to grow. People needed more things to use and more food to eat so sophisticated tools and equipment were invented to cater for all these needs and wants. Waste and pollution then became a problem.



Papua New Guinea is one of the countries in the world today dealing with the waste and pollution problem. As the population grows in PNG, the demand for consumption of better goods and services increases. This demand places pressure on our resources, for example, forest for timber, flat and suitable land for agriculture, and minerals, oil and gas deposits for revenue and infrastructure development needs. All these development occur in order to support our country's economy, however, in the production to the end use stage they create more waste that affects the environment we live in. We must learn to manage our waste, minimize pollution occurring in our natural environment, and promote sustainable natural resource management through proper planning and management.


PNG's natural resources belong to the people as land is owned as customary land. However, the management of these resources are carried out by the Government. The Government established laws to govern the exploitation of renewable and non-renewable resources. In PNG, the laws are there to guide the development of these resources; however, many times these are not always followed. The renewable and non-renewable natural resources are overharvested, mined or our economy is stolen by illegal money laundering due to a lack of good governance and management. Good governance and sustainable management during the exploitation of the resources and the good use of the revenue for today and into the future is critical.

In this unit, you will teach your students to understand and know more about how to manage waste, reduce pollution and avoid over exploitation of natural resources in their communities and the natural environment around them. They will also understand the concepts relating to the exploitation of our natural resources. Activities in the lessons must be practical to help students to practise positive attitudes in the disposal and management of waste and reduction of pollution in their communities. They must be taught to process and analyse information that will help them to realise the consequences of their own actions and that of others that will have an impact on their environment.

TOPIC 1: WHAT IS WASTE?

Waste refers to any material that is unused and rejected as worthless or unwanted. These are items we don't need and throw away. Some can be small like a biro and small can be so big like a truck. Everyone creates waste and these wastes causes environmental pollution.

Waste in PNG arrived with modernisation and urbanisation. In traditional PNG societies, all items used for daily living were made from natural sources. For example, timber for house posts and making canoes, bamboo for making hair combs and fencing, cane for rope, hardwood for wooden bowls, clay for clay pots are some examples. These and all other traditional items needed for daily living were from natural sources. At that time, once their current use was finished, the item was thrown away and nature simply broke down the waste back into the soil.



With modernisation, a wide range of activities took place. Modern towns and cities were built to house an urban population. These places needed sewerage systems, water purification plants, supply of electricity, major shopping centres, banks, and industrial areas. Other development took place. Logging trees for timber, mining for copper, gold, zinc, cobalt, iron and other minerals, clearing forests for timber and conversion to cocoa, coconut, oil palm and subsistence food gardens.

Take a look around your community and identify the kinds of waste - things like plastics, tins, old discarded clothes, scrap metal and many other items. If you live by the sea, what kind of waste can you identify when the tide is low? You may be surprised at the amount of rubbish the waves bring to your shore or the rubbish disposed of by people in the communities. What happens to organisms when their habitats are invaded by foreign objects?

As a result of modern living, we now have to deal with many kinds of waste. Waste can be seen in the form of a liquid or a solid. Examples of liquid waste are: used water from homes (kitchen, laundry and sewage), liquids used for cleaning in factories and industries such as detergents, mechanical waste such as oil, grease and other lubricants, and agriculture farm chemical pesticides and food wastes. Examples of solid waste are: garbage or rubbish that we make in our homes and other places. These include empty tinned food and can or plastic drinks, shopping plastic bags, old tyres, old clothes, broken furniture, old newspapers and food waste.

There are other types of wastes that are hazardous and harmful to all living organisms including people in the environment. These wastes could be inflammable (*can easily catch fire*), reactive (*can easily explode*), corrosive (*can easily eat through metal*) or toxic (*poisonous to humans and animals*).

Organic waste comes from plants or animal sources. These sources include food waste, fruit and vegetable peels, trimmings from flower and vegetable gardens and animal wastes. These are all classified as organic waste. This waste is biodegradable (easily broken down by other organisms over time) and turned into manure or compost and recycled in farming. Many people turn their organic waste into compost and use them in their gardens.

Big industries like the oil palm industry create chemical waste when chemical fertilizers, insecticides and weed control chemicals are used on the palms. Environmental laws must be enforced on these types of industries to ensure that the environment is safe from being polluted by chemical waste.

Mining is an extractive industry that contributes to producing tonnes of wastes. It involves the digging up rocks and soil in the crust of the earth usually several kilometres deep into the ground for gold, copper, aluminium, tin and other minerals. Huge rocks are dug up, crushed, and washed as slurry in the refinery to extract minerals. The slurry (dissolved muddy wastes) is dumped into river systems like Fly River in Western Provinces. The surface soil removed is piled up as mine waste, and soil erosion washes the soil downstream and causes sedimentation into streams and creeks. After the copper or gold is dug up, the raw rock containing the minerals

are washed down with chemicals. These chemicals run into the rivers through pipes from the mine site.



Fig. 26 Photo of Ok Tedi Mine tailings waste dump into Fly River Systems killing aquatic life forms

Strict Environmental Laws on chemical waste from mining are enforced to control the quantity of chemicals being discharged into the rivers. Rock wastes from the mine site such as the Ok Tedi Mine in the Western Province were washed into the Fly River. This has caused more chemical waste flowing into the Fly River and causing damage to the organisms in the river as well as the people who rely on the Fly River as a source of their livelihood.

Similarly, the Lihir and Simberi gold mines in PNG dump their mining waste into the deep ocean. This chemical waste is poisonous. Plants and animals are harmed by these wastes.

In PNG, the Environment Act 2000 contains strong laws that the government uses to manage mining companies in the disposal of chemical wastes.

LESSON 21A – Junior Primary

Name of Lesson: Is it Waste?

Objective: By the end of this lesson, students can:

- Define what wastes are.
- Recognise materials that can be used again.

Key Knowledge:

1. Waste is an unwanted or unused product of any process.
2. Wastes can be recycled - waste items that can be used again can be separated from those that cannot be used again.

Materials Needed: Recycled food packets, example: milk, rice, etc. used tinned fish and Sunshine milk tins or poly bags, scrap papers, banana skins, plastic bottles, batteries, empty cans, glass bottles, paper boxes, and newspapers.

Preparation: Students are to bring two waste materials from their homes or from the school a day or two before the actual lesson. Have your students work in about four groups.

Activity: Creating Waste or No Waste - Introduce the term 'waste'. Ask the class to give their views on what this means. Make notes on their responses on the blackboard. Explain that *a waste is an unwanted or unused product of any process*. In this case, it refers to materials that are no longer needed or cannot be used anymore. For example, all the materials students have brought from home before this lesson are wastes.

Tell the class that in this lesson they will look at all the wastes each student has brought in. Stick two newspaper sheets on the floor; one on each side of the class. Write (*Can be used again*) on Sheet A, and (*Can't be used again*) on Sheet B.

Then ask each group to take the waste materials that they have brought and place these on either *Sheet A* or *Sheet B* depending on where they think their material should go. Give each group time to carefully put all their waste items on either of the two sheets.

Ask the whole class to study the displayed materials carefully. Then ask each group to explain:

- What they will do with the items that can be used again placed on *Sheet A*.
- Why they think the items they placed on *Sheet B* cannot be used again.

Discuss each group's responses. Emphasise the importance of recognising items that can be used again so that the amount of waste generated is reduced. Also, items that are considered of no use at the time of separating them, maybe useful for another purpose in another situation.

Tell the students that anything made from paper, plastic, aluminium, steel, and glass can be used again, then have them dispose off these items correctly.

Evaluation/Homework: Remind students that some things they get rid off as wastes can be used again. For homework, ask students to make a list of several ways they can reduce their wastes produced at home and the school. This can be discussed in the next lesson.

LESSON 21B – Junior Primary

Name of Lesson: Reduce, Re-use & Recycle.

Objective: By the end of this lesson, students can:

- Explain the terms re-use, recycle and reduce in waste management.
- Identify the difference between recyclable and non-recyclable wastes.
- Examine their own personal activities that create wastes.

Key Knowledge:

1. Re-use recyclable wastes in different ways.
2. Reduce human activities that generate wastes.

Materials Needed: Used/new hand gloves or home-made gloves, plastic bags or used rice or flour bags, used oil or fuel containers/drums to collect wastes.

Preparation: Write the terms *re-use*, *recycle* and *reduce* on flash cards. Provide some used shopping bags or flour/rice bags for students to use. Ensure that your students work in three big groups.

Activity: Reduce, Re-use, Recycle - Introduce the term 're-use', 'recycle' and 'reduce' using flash cards. Have these terms pasted on the blackboard with space between each term. Ask the class to give their views on what each of these terms mean. Make notes of their responses on the blackboard. Then explain each term as follows:

- *Re-use* - to use materials in their original form instead of throwing them away.
- *Recycle* - to process materials or substances (such as liquid waste, paper, glass, or cans) that can be used again for other purposes.
- *Reduce* – use resources wisely and also, use less than usual in order to avoid waste.

Write these explanations on the blackboard. Then have the students get into their three groups. Allocate one of the terms to each group *i.e.* *Group 1 – re-use, Group 2 - recycle and Group 3 - reduce*. Tell the class that they will go through the whole school campus and find wastes thrown by students and teachers on the school grounds that fit their group name. They should pick these up and bring them to the lawn/concrete pathway outside their classroom. Assemble these wastes according to the three R's.

Ask the students about what they could do with each of these wastes. Each group can respond accordingly. Then have the students set aside the recyclable wastes apart from the non-recyclable wastes. Tell the class to dispose the rest of the wastes correctly before washing their hands and returning to the classroom.

Ask the students to share their views on what the school can do to separate all the wastes according to the three R's. Make notes on the blackboard.

Evaluation/Homework: Tell the students that wastes can be separated into recycle or non-recyclable and that they can start this in their classroom and home. For homework, ask students to practice at home by separating the wastes as recyclable or non-recyclable.

LESSON 22A – Senior Primary

Name of Lesson: Recycle and Reuse.

Objective: By the end of this lesson, students can:

- Make personal changes to their waste output so that they can create a positive impact on the environment.
- Develop awareness towards littering by classifying the type of rubbish that can/can't be recycled.

Key Knowledge:

1. Recyclable wastes can be used in different ways.
2. Human activities that generate wastes must be reduced.

Materials Needed: Recycled food packets, example: milk, rice, etc. used tinned fish and Sunshine milk tins or poly bags, aluminium foil, scrap papers, banana skins, plastic bottles, batteries, empty cans, glass jars, aerosol cans such as Mortein insect spray, paper boxes, and some newspapers. An item representing each of these should be placed inside four used shopping bags labelled A, B, C & D.

Preparation: This activity may take two lessons. Students are to bring four waste materials from their homes or from the school a day or two before the actual lesson. It is advisable to have your students work in groups.

Activity: Creating Awareness about Waste - Begin the lesson by writing the terms *re-use*, *recycle* and *reduce* on the blackboard. Discuss these key terms and concepts, focusing on recycling as the process of using old items to make new items.

Tell your students that when they recycle old notebooks and newspapers, these are used to make new things instead of simply sitting in a rubbish dump. Tell your students that paper, plastic, aluminium, steel, and glass can be recycled or reused.

As a class, brainstorm on different types of recyclable items that they might encounter on a daily basis. Discuss their daily activities and the recyclable items involved in each. For example, eating (plastic cups and dishes, aluminium food and drink containers, cardboard cereal boxes, plastic milk jug, etc.), doing school work (paper, printer ink cartridges, and electronics), purchasing products from the store (plastic packaging, cardboard boxes, and plastic containers), etc.

Divide the class into four small groups. Assign each group a letter name: A, B, C and D. Give each group one bag. The groups are to write on the board the names of the items in their bags. The group must focus on their bag and decide if any of the items could be recycled.

Stick four used papers glued together as a sheet; on each side of the classroom. Write (Can recycle) on sheet 1 and (Can't recycle) on sheet 2.

The group leader should appoint one student in the group to do the writing. Write on sheet 1 the name of the items they have decided to recycle, and on sheet 2 the items which will go to the rubbish dump. Leave the newspaper sheets hanging for a later discussion.



The groups are to discuss and write down:

- Why they think the items they chose from their bag cannot be recycled.
- What they will do with the items they chose to be recycled.

Each group will present the result of their discussions to the class. Discuss further about what they can do with the items that can be recycled and reused. You can develop a lesson on how these waste items can be made into useful things for students to use at home or give away as gifts.

Note: This lesson introduces students to the concept of recycling and waste reduction. Students will investigate how materials are recycled, what materials can be recycled and why recycling is so important to protect our environment.

Evaluation/Homework: Ask students a few questions on what recycle and non-recyclable are and to give some examples of each. For homework, students can prepare a poster on no dumping of wastes into the river or water ways. This can be discussed in the next lesson.

Assessment Activity: This is an assessable activity. The assessment is both informative and summative therefore you have many different ways to assess this activity. Use a set of criteria to help you in assessing this activity.

LESSON 22B – Senior Primary

Name of Lesson: Mini School Recycling Station.

Objective: By the end of this lesson, students can:

- Develop negotiation skills by listing solutions to help reduce littering.
- Create posters to promote saving the environment.
- Set up a mini recycling station for the whole school.

Key Knowledge:

1. Recyclable and non-recyclable wastes must be disposed separately.
2. Plan, design and implement school-based projects for waste management.

Materials Needed: Used fuel drums or large empty containers like 44 gallon drums, large plastic bins can be bought from the hardware store if school has money, large pit or deep hole can be dug out at one side of the school for non-recyclable items.

Preparation: This activity will take two or three lessons. The preparation of the project can also be combined with other subjects like Agriculture.

Activity: Recycling Station – Start the lesson by asking students to define the terms *re-uses*, *recycle* and *reduce*. Ask them to explain what they think it means in practical terms. Make notes of their responses on the blackboard.

Tell the class that they will plan, design and construct a mini recycling station for the whole school. Have a general class discussion on what each student thinks. Have at least two or three students to be scribes to record the class discussion. Present the plan to the class for feedback.

After further elaboration, take the materials to the chosen site and begin the setting up of the recycling site. First, construct a proper shelter or use an existing one. Then organise the empty drums by painting them using different colours e.g. orange for recyclables 1 i.e. glass, bottles and plastic; yellow for recyclables 2 i.e. tins and cans; blue for paper and green for biodegradables. All non-recyclable items should be placed in the pit or hole which was dug on one side of the school ground.

Note: The recycling station can be officially opened after completion. The class can also use the opportunity to create awareness on proper waste management.

Evaluation/Homework: Students can prepare information posters about proper waste management and put up at the mini recycling station.

Assessment Activity: This is an assessable activity. The assessment is both informative and summative therefore; you have many different ways to assess this activity. Use a set of criteria to help you in assessing this activity.

TOPIC 2: WHAT IS POLLUTION?

Pollution is when waste is not treated well or reduced or changed into other types of material. These can be treated again to break it down further. However, when this does not happen and the rubbish is left to pile up in the environment; that situation gives rise to pollution or contamination. Pollution therefore, refers to untreated or toxic (poisonous) wastes. Pollution can be on land, in rivers and lakes, in the forest, in the mining areas, in urban cities and villages, on the beaches, in the oceans and in the air.

Pollution is when gases, smoke and chemicals are introduced into the environment in large doses that makes it harmful for humans, animals and plants. Some forms of pollution can be seen, some are invisible. Pollution happens when the environment is contaminated by waste, chemicals, and other harmful substances. There are three main forms of pollution: *land, water and air*.



Land Pollution

Water Pollution

Air Pollution¹⁷

Wildfires, volcanoes, and industrial chemicals cause some air pollution. But most air pollution comes from the burning of fossil fuels. These include coal, oil, and natural gas. Factories, electrical plants, and automobiles burn these fuels for power. The burning of fossil fuels may release solid particles, such as ash and soot, into the air. It also may release harmful gases. This type of pollution may be seen in the form of smog or smoke over big cities.

Land Pollution

Think about how much rubbish is produced by 7 billion people? Did you ever think about where the rubbish goes? Some of the things that we throw away are toxic to our environment, like plastic. They contain chemicals that can leak into the ground and contaminate the water we drink. These chemicals can even reach our oceans, rivers and lakes. We must learn to *Reduce, Reuse* and *Recycle* our rubbish. We must try to minimise the amount of waste that ends up in the landfills so we won't contaminate our environment. This is an effective way to manage our waste and keep them from reaching our landfills.

¹⁷ <https://www.bing.com/search?q=air+pollution&go=Search&qs=ds&form=QBRE>



Fig. 27 Photo of land pollution at Kaimari Market, Moro, Lake Kutubu, SHP. Photo: Kyaro@WWF/2019

In Port Moresby and other provincial towns, lots and lots of plastic bottles, plastic bags and other rubbish are carelessly thrown everywhere and end up in storm drains. Waste drums for people to drop their garbage in are not placed in public places, so people leave all their rubbish everywhere. During the rainy season, rubbish is washed into storm drains and thereafter, onto the beaches and ocean every year. Another important urban waste is sewerage treatment in urban towns which is an ongoing challenge. Raw untreated sewerage is polluting underground waters. Usually urban settlements without proper toilet facilities or links to the town supply means that raw sewerage flows into storm water drains instead of sewerage pipes that take the sewerage to treatment plants.

The National Capital District Commission (NCDC) and other provincial city and town authorities have established laws about keeping the cities and town clean. They employ people to clean up the cities and towns. There are laws written too, about penalising people and business houses that are careless with their wastes.

In addition, mining occurs on land. Therefore, waste dumped into rivers and the ocean has polluted many freshwater waterways and oceans of the world. Mining waste includes soil and rocks from the mine pits that are dug up and stored either next to the mine site or dumped into rivers. Land based mines in PNG that do this are the Ok Tedi Copper and Gold Mine in Western Province, the Porgera Gold Mine in Enga Province, and the Lihir Gold Mine on Lihir Island in New Ireland Province. In this case, International and National Laws have been established to manage large industrial wastes.



Fig. 28 Agricultural chemical spray at NBPOL Estate, Kimbe, WNPB. Photo: Kyaro@WWF/2017

Agricultural crops like oil palm plantations use chemicals to kill off un-wanted insects. Soil fertilizers are used to keep soils fertile with the necessary nutrients to support oil palm growth. These chemicals, after being sprayed or placed in the soils, can be washed into nearby streams and rivers and cause death or harm to aquatic life. The Environment Act 2000 law protects the environment and states the management measure to manage chemical pollution.

Water Pollution



Fig. 29 Water pollution in a swampy area near Kaimari Market, Moro, SHP. Photo@WWF/2019

What will we do when we run out of clean water to drink? What will happen when the oceans, rivers and lakes are so polluted that all the fish and aquatic animals die? Water keeps us alive and it's very important for us to have clean drinking water. We don't know if the water is really safe to drink and we buy purified water in bottles.

Humans are the cause of water pollution, directly and indirectly. We mindlessly throw our rubbish in the sea and ocean, not thinking about what that may cause. Ships that carry oil can have accidents, spilling all that toxic oil into the ocean, causing havoc in our marine ecosystems and polluting our waters.

We must learn to stop throwing our rubbish into the sea and dispose them properly on land. By knowing how our daily activities affect our environment, we can help reduce pollution in our own small way.

International laws deal with pollution by vessels and boats travelling between countries. Captains are warned not to throw their rubbish into the ocean. PNG has established the National Maritime and Safety Authority to enforce pollution to manage ocean pollution for boats and vessels travelling to and fro on the oceans.

Air Pollution

The vehicles that we use to get around such as cars, buses, planes and trucks contribute to air pollution. These vehicles use fossil fuels, like petrol, diesel and gas, to power its engines. The smoke that comes out of our vehicles is carbon dioxide. Due to the large number of vehicles in the world today, we are adding too much carbon dioxide to our atmosphere, causing the planet's temperature to rise. This is global warming.



Fig 30 Chimneys in factories & forest fires produce excess smoke that pollutes the air

The toxic smoke coming out of our vehicles is just a small part of our air pollution problem today. Factories which are used to produce many of the consumer products we enjoy every day also give off toxic substances that pollute our air. Not only does air pollution cause smog, it also causes sickness such as asthma and other respiratory diseases.

Air pollution is controlled and managed by both international and national laws of a country. In PNG, the PNG National Airports Authority manages pollution by airplanes.

Think about your environment. Is your rubbish disposed of properly? Is your environment also polluted? What can you do to ensure your environment and the habitats of organisms that are in your environment are protected from waste and pollution?

LESSON 23A – Junior Primary

Name of Lesson: What is Pollution?

Objective: By the end of this lesson, students can:

- Define the term *pollution*.
- Recognise land, air and water pollution.

Key Knowledge:

1. Pollution is harmful to plants, animals, land, water, atmosphere and people.
2. There are types of pollution – land, air and water.

Materials Needed: Toxic wastes items such as old car batteries, and alkaline batteries; used house paint, oil and grease tins; empty aerosol cans, pesticides and insecticides.

Preparation: Collect samples of the toxic wastes items a day or two days before the lesson. Have these items as display only on the teachers' desk. Advise your students not to touch these items unless under your supervision.

Activity: Identifying Types of Pollution – Begin the lesson by holding up a glass or bottle of clear water. Ask the class what they think will happen if used engine oil is poured into the clear water. Allow them to orally share their opinions. Then pour the used engine oil into the bottle of water. Allow responses from students which should also indicate that the clear water in the bottle has been polluted by the engine oil so it has become dark.

Introduce the term *Pollution* at this stage i.e. *Pollution* is when harmful or poisonous (toxic) substances are introduced into the environment. This can be in the form of solid, liquid or gas pollution can harm the people, plants, animals and the environment in general.

Tell the class to work in four groups to brainstorm on different types of toxic wastes and the type of pollution these can cause. Have the students discuss in their groups and present to the whole class. Make notes of these items on the blackboard. For example:

TYPE OF TOXIC WASTE	TYPE OF POLLUTION
Car oil	Land and Water
House paint	Land
Mortein spray can	Air and Land

Display samples of different toxic wastes on the teacher's table in front of the classroom. Have the class name these different items.

Evaluation/Homework: Remind students that pollution harms people, plants, animals and the environment in general. For homework, list at least two ways toxic wastes can be disposed off to minimise pollution.

LESSON 23B – Junior Primary

Name of Lesson: Stop Pollution!

Objective: By the end of this lesson, students can:

- Describe safe ways to dispose off toxic wastes create awareness on safe disposal of toxic waste.

Key Knowledge:

1. Toxic wastes are harmful to plants, animals and people.
2. Dispose off toxic wastes correctly.

Materials Needed: Rubber gloves, plastic shopping bags, A4 papers, pencils, water colours, coloured pencils, etc.

Preparation: Provide rubber hand gloves and plastic bags for waste removal a day earlier, organise students into the working groups.

Activity: Creating Awareness about Toxic Wastes - Brainstorm on different types of toxic wastes. List these on the blackboard e.g. car or engine oils, house paints, morten spray and so on. Ask students to say how this item can cause pollution and how it can be disposed off correctly. Students can suggest their views on what they think. Explain that in most cases, toxic wastes are buried in a hole and covered to avoid pollution.

Tell the class that in this lesson they will do a school campus clean-up of toxic wastes. Use the *Activity Sheet 5.1* to find the toxic wastes in the school grounds. Other recyclable and non-recyclable wastes should also be removed during this activity. Use hand gloves and plastic bags provided to remove the wastes.

Ensure that one of the groups is responsible for digging the pit or hole with the help of some big students and teachers. All toxic wastes found on the school grounds should be placed inside the hole and covered. All used gloves and plastic bags should also be placed inside the hole and covered with the toxic wastes. Ensure all the students have washed their hands with soap and water after this activity.

Note: Waste removable should be done with teacher supervision.

At the end of the clean-up, have each group design a poster to inform students and teachers about the correct ways to dispose off toxic wastes. For example:

Evaluation/Homework: Students can complete and colour their posters for display in the next lesson.



Activity Sheet 5.1 – Types of Toxic Wastes

Can you spot these toxic wastes on the school grounds?



POISONOUS WASTE



PAINT & BRUSH



LESSON 24A – Senior Primary

Name of Lesson: Toxic Wastes and Pollution.

Objective: By the end of this lesson, students can:

- Describe the relationship between toxic wastes and pollution.
- State that toxic wastes cause air, land and water pollution.

Key Knowledge:

1. Toxic wastes cause air, land and water pollution.
2. Pollution is harmful to plants, animals and people.

Materials Needed: Toxic wastes items such as old car batteries, and alkaline batteries; used oil based paints, oil and grease tins; empty aerosol cans, pesticides and insecticides.


Preparation: Collect samples of the toxic wastes items a day or two days before the lesson. Have these items as display only on the teacher's desk. Advise your students not to touch these items unless under your supervision.

Activity: Toxic Wastes and Pollution - Brainstorm as a class on what types of toxic wastes are within their reach and how they are produced. Make note of the class discussions on the blackboard.

Explain to the class that toxic wastes are produced from chemicals and other harmful substances. These substances if not controlled or managed can leak into the land, water ways and air and become harmful to people and environment. Plants and animals can also be harmed by such leakage.

Have students look at the display of toxic items on the teacher's table. Students are to decide on which of these items are harmful to air, land or water. Also suggest what alternatives can be used instead of these items. Their responses can be presented in a table like the one below.

TOXIC WASTE ITEM	TYPE OF POLLUTION	ALTERNATIVE ITEM THAT CAN BE USED
Oil base paints	Land	Water based paint
Engine oil	Land and water	Clear organic oil base
Factory made insecticides	Air	Herbal spray
Battery	Land and water	Rechargeable battery or solar battery
Mortein insect repellent spray	Air	Plant based repellent



Have a discussion on the different alternatives that can be used instead of the toxic stuff made in factories. Most of the alternative substances are made from organic stuff such as plants or animal based products.

Tell the class that some of these alternative products can be made from simple everyday items. For example, instead of using factory made insecticide to spray on cash crops or vegetables, a plant based product can be used. One example would be to make chilli spray. Students can prepare this to be used at the school's flower or cash crop garden.

Divide students into four groups. Distribute red chillies and a one litre container. Help them to prepare their chilli spray as follows:

- a. Mix a handful of squashed red chillies with water in a one litre container. Leave this overnight.
- b. On the next day, sprinkle it on crops/plant leaves where you see lots of crawling insects.
- c. Apply this twice a week.

Evaluation/Homework: Remind the class that toxic wastes cause air, land and water pollution. For homework, students can take their chilli spray home and test it the next day.

Assessment Activity: This is an assessable activity. The assessment is both informative and summative therefore you have many different ways to assess this activity. Use a set of criteria to help you in assessing this activity.

LESSON 24B – Senior Primary

Name of Lesson: Protecting Waterways.

Objective: By the end of this lesson, students can:

- Develop negotiation skills by listing solutions to help reduce pollution
- Carry out a clean water project to stop water pollution.

Key Knowledge:

1. Water ways and sources should be free from pollution.
2. Plan, design and implement school-based project to clean the waterways.

Materials Needed: Rubber gloves, plastic bags or used stockfeed bags, A4 papers, markers, water colours or pencils.

Preparation: Divide students into four work groups, tell students to bring some dry clothes and towel as they will be walking into or near the water.

Activity: Clean up Your Water - To begin the lesson, display two bottles of water – one from the creek or river near the school and another from the tank. Ask the class to compare the two water sources and describe what they see. Students' responses should show that creek or river water where many people use for washing has a lot of dirt, rubbish, insects, and so on as compared to the tank water. Explain that the creek or river water is polluted.

Water can become polluted when it's contaminated by chemicals and other household substances. Explain to the class that chemicals and other harmful substances are also present in toxic wastes. These substances if not controlled or managed can leak into the land, waterways and air and become harmful to people and environment. Plants and animals can also be harmed by such leakage.

Tell the class that for this lesson, they will visit the local creek or river to do a clean-up. Students should work in four groups. Each group will cover a certain part of the creek/river. They will use plastic bags or stockfeed bags to put their rubbish in. They must also wear rubber gloves to avoid touching the wastes with their bare hands. All wastes removed from the waterways should be disposed off correctly.

Explain that toxic wastes must be buried in a hole and covered immediately. Recyclable wastes should be placed in the correct disposal site and non-recyclable wastes should be disposed off in the correct place. As a concluding task, have each of the groups design a poster, brochure, pamphlets or factsheet informing communities to dispose all wastes correctly and not in the water. These awareness materials must also contain information about the importance of water and the dangers of toxic wastes in the water.

Evaluation/Homework: Have students complete their awareness package to distribute in the community during the next lesson.

Assessment Activity: Develop your own set of criteria to help you in assessing this activity.



TOPIC 3: EXPLOITATION OF NATURAL RESOURCE?

In a general sense, *exploitation* is simply the *act of unfairly using or developing resources for the benefit of something*. It refers *to the use of a resource at a rate dictated solely by the demand for that resource, and with no effort expended to replenish that resource in the future*. The resource is harvested and then the harvesters move on to another place when the supply is exhausted.

A. Types of Natural Resources

Natural resources can be divided into several categories as discussed below.

(1) Nature's Goods

These are the traditional "extractable" resources such as:

- Fossil fuels: oil, coal, and natural gas.
- Metallic ores: iron, copper, silver, gold etc.
- Biological supplies: timber, fisheries, wild game, and natural rubber.

(2) Nature's Services

These are essential services provided by nature for the continued, sustainable health and well-being of our environment. These are typically considered "renewable" resources such as:

- Soil for production
- Water and the hydrology cycle
- Air and purification of air
- Global carbon cycle
- Stratospheric ozone shield


(3) Natural Amenities

These are non-essential services provided by nature; may be considered as services that provide a "quality-of-life". For example:

- Recreation
- Aesthetic or for enjoyment

B. Exploitation of Natural Resources

Exploitation of natural resources is an essential condition of the human existence. Throughout history, humans have manipulated natural resources to produce the materials they needed to sustain growing populations. This refers primarily to food production, but many other entities from the natural environment have also been extracted. Often the exploitation of nature has been done in a non-sustainable way, which is causing an increasing concern, as a non-sustainable exploitation of natural resource ultimately threatens the human existence.



There are many examples of exploitation of natural resources, both in our history and in the present day. For example, clearing of primary forest, plowing of grasslands, and the relentless hunting pressure on native species that can lead to extinction of wildlife such as pig-nosed turtles, tree kangaroos, endemic fish population in Lake Kutubu, and forest resources for local needs contribute to resource depletion. Exploitation is alive today in such things as the poaching of wildlife, clearing of tropical forest for oil palm plantations, management of several marine fisheries, and agriculture expansion in swamp lands.

Current Trend in Exploitation of Natural Resources

The exploitation of natural resources is always associated with a negative implication of accompanying environmental degradation. It started to emerge on an industrial scale in the 19th century as the extraction and processing of raw materials (such as in mining, steam power, and machinery) developed much further than it had in pre-industrial areas. During the 20th century, energy consumption rapidly increased.

Oil & Gas


Today, about 80% of the world's energy consumption is sustained by the extraction of fossil fuels, which consists of oil, coal and gas. In PNG we have a large scale industrial economic development of the construction of a PGK 11.6 billion gas pipeline from the Southern Highlands to Queensland. The oil and gas extraction started in Kutubu area in the Southern Highlands Province in early 1990s. It has expanded into Hela, Gulf, Western and Central Provinces and in 2012 full scale development commenced on the infrastructures like roads, airport, wharves, camps, gas & oil pipelines, refinery and other facilities. A huge project covering four provincial governments of SHP, Hela, Western, and Central Provinces. The revenues generated from this project have improved the economy of PNG and neighbouring Pacific countries, too. However, while such natural resources are highly valuable, they are also non-renewable resources. They are extracted for fossil fuel for industrial, lubricants, fuel for transport sector (road, air & sea) and other bi-products.

Mineral Sand

The mineral sand is a non-renewable resource. It contains precious metals that are mainly used in the production of industrial commodities. In Kikori River Basin, the Mayur Resources Ltd is advancing the exploration and prospecting of the mineral sand bed mining in the Gulf Province, especially on the delta region of the Gulf of Papua. The Myur Resources who holds the tenement license is currently prospecting the Orokolo Bay Industrial Sand Project which party covers the Kikori River Delta Region.

Coal

The Mayur Resources holds a portfolio of tenements that cover the main coal bearing geology in the Papuan Basin in southern PNG. Although there has been a long history of coal prospecting in the Gulf Province, coal mining has never been developed in PNG, unlike its neighbours in Indonesia and Australia.



The Gulf region includes the outcropping ‘Shu Coal Measures’ (within the coal-bearing Era Beds formation) and is generally low lying and home to some of PNG’s major river systems including the Purari, Vailala and Kikori, that offers potential options for transport and access. The most advanced deposit in the portfolio is at Depot Creek located approximately 20km from the Purari River.

Timber Resource

The large scale forestry development are managed and regulated by the PNG Forest Authority (PNGFA). In PNG, the proposed or current logging concessions cover 21,000,000 ha (210,000km²). In Kikori River Basin, there are nine Forest Management Agreement (FMA) Concessions covering 1.1million ha (approx. 50%) of 2.3 million ha proposed World Heritage Site area¹⁸. It spans across extensive land area from the mouth of Kikori River and the Delta area to the inland of Mt Bosavi and Nipa-Kutubu regions. Where five¹⁹ FMAs are active logging operation sites and the remaining four are proposed concession areas²⁰.

Agriculture

Intensive agriculture is an example of a mode of production that hinders many aspects of the natural environment. For example, the degradation of forests in a terrestrial ecosystem and water pollution in an aquatic ecosystem. As the world population rises and economic growth occurs, the depletion of natural resources influenced by the unsustainable extraction of raw materials becomes an increasing concern.

In Kikori River Basin, the Small Agriculture Business Lease (SABL) area, especially proposed for Palm Oil Project primarily over the logged forestry concession areas. There are eight proposed SABL, Palm Oil project sites in Kikori River Basin²¹ and covers approximately 774,826ha (7748.26km²).

The palm oil industry is PNG’s most valuable agricultural export (by the end of 2014, contributing roughly 65% of PNG’s agricultural exports²²) and the largest non-government employer²³. It is clearly important economically to PNG and a major reason for government issuance of SABLs, which, through gaps in the legislative and policy framework, allow companies to illegally log and landgrab for large-scale agricultural development. Since 2014, 60 SABL licenses have been granted in PNG. The SABL areas in Kikori are a part of government issued permits under development.

Many of these threats can only be addressed through coordination under the context of a catchment management programme now being initiated by WWF with key partners. A

¹⁸ WWF PNG Report (2017)

¹⁹ Turama, Turama Block 1, Kikori Block 2, Baimuru block 3, and East Kikori

²⁰ Bosavi, Hekiko, Kutubu-Poroma, and Nogoli

²¹ COMMISSION OF INQUIRY INTO THE SPECIAL AGRICULTURE AND BUSINESS LEASE (SABL), FINAL REPORT (June 2013), John Numapo Chief Commissioner Port Moresby

²² http://www.pg.undp.org/content/papua_new_guinea/en/home/presscenter/pressreleases/2017/04/24/positioning-png-as-a-global-leader-in-sustainable-palm-oil-production.html

²³ Nelson et al, 2013

partnership of NGOs, government, and corporate bodies offers a possibility for sustainable finance for effective management of the region.

In 2012-2015, WWF work focused on developing Kikori River Basin Conservation Blue Print/Land use plan. The Blue Print/Land use plan provides guidance to future land use planning, and a balanced approach to the current onset of logging, oil and gas investments or government infrastructure developments.

Dialogue with government departments is maintained to lobby support and influence policy change and adoption of sustainable land use practices in respective land development sectors and industries. WWF continues to provide support for development of livelihood and income generation activities for local communities. The livelihood initiatives have begun in eco-tourism, community eco-forestry enterprises, food security, biological research & Reduced Emissions from Deforestation and Degradation (REDD) + & climate change adaptations.

Consequences of the Exploitation of Resources

The following consequences can arise from the careless and excessive exploitation and consumption of our natural resources:

- Deforestation
- Desertification
- Extinction of species
- Forced migration
- Soil erosion
- Oil depletion
- Ozone depletion
- Greenhouse gas increase
- Extreme energy
- Water pollution
- Natural hazard/Natural disaster
- Metals and minerals depletion



Fig. 31 Deforestation caused from conversion of forest to Palm Oil Plantation in Bewani, WSP. Photo@Kyaro/WWF/2017

Why are our natural resources under pressure?

The root cause of over exploitation of natural resource is basically due to;

- a. Over population
- b. Inefficiency in resource utilisation
- c. Over consumption
- d. Poverty
- e. Ineffective Structures (e.g. Human Institutions, Regulations and Attitudes)

Other reasons are the increase in the sophistication of technology enabling natural resources to be extracted more quickly and efficiently. For example, in the past, it could take long hours just to cut down one tree only using saws. Due to increased technology, rates of deforestation have greatly increased.

Cultures of consumerism. Materialistic views lead to the mining of gold and diamonds to produce jewellery, unnecessary commodities for human life or advancement. Consumerism also leads to extraction of resources for the production of commodities necessary for human life but in amounts excessive of what is needed, because people consume more than is necessary or waste what they have.

Excessive demand often leads to conflicts due to intense competition. Organisations such as Global Witness and the United Nations have documented the connection. Non-equitable distribution of resources is becoming problematic.

Renewable Resources



Fig. 32 Timber and other forest resources are examples of renewable resources

Renewable resources consist of commercial agriculture, livestock, forestry and fisheries resources. Agricultural production for international trade includes coffee, tea, rubber, copra, cocoa and oil palm. Livestock include cattle, sheep and crocodile production.

The forestry sector is focussed on log exports for areas in PNG where licensed logging companies operate. The fisheries sector exports tuna, lobsters and prawns. Exploitation of renewable resources in PNG is by both foreign companies and citizens.

Planning for development and land use planning is a must to address the revenue needs of the country and population growth, especially for logging and setting up of large commercial estates for oil palm. In many parts of PNG, large tracts of forests containing valuable biodiversity have been permanently removed.

Non Renewable Resources

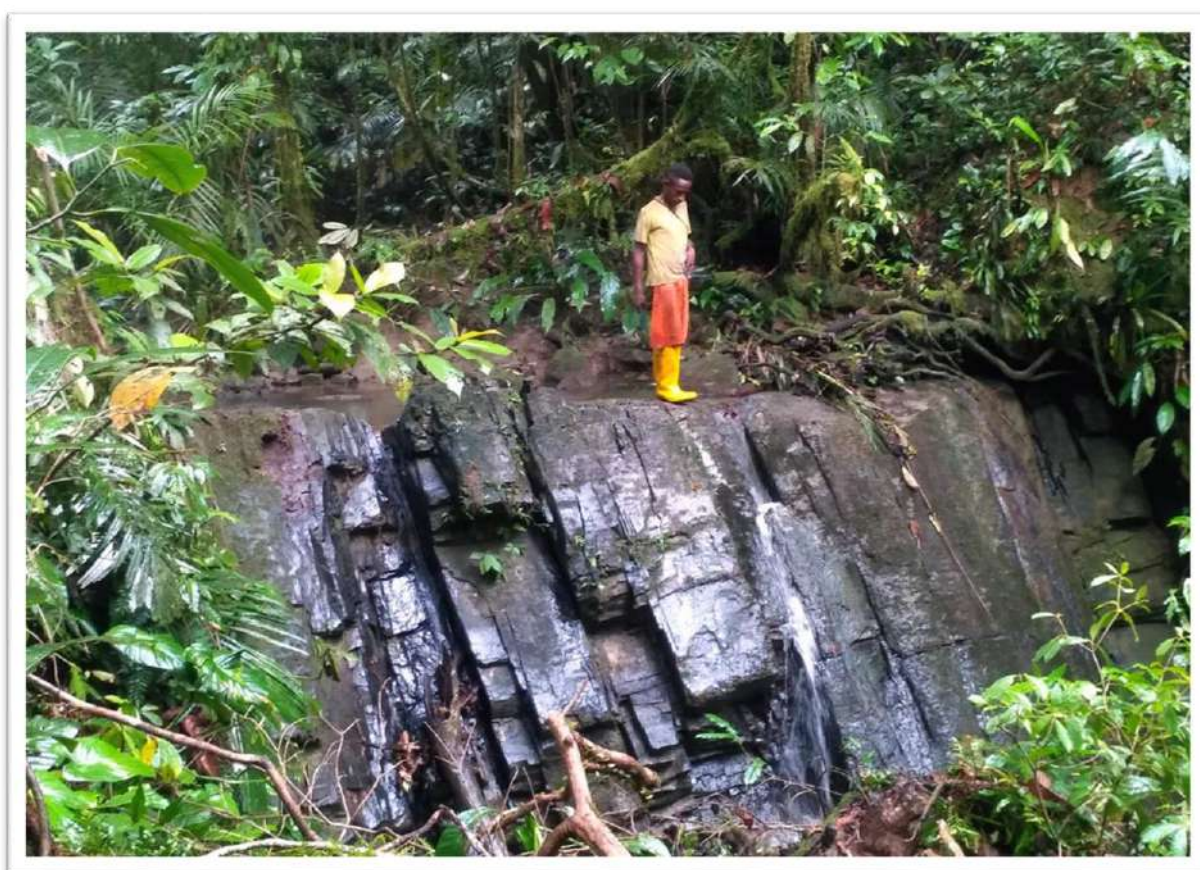



Fig 33 Coal Deposit in Gulf Province currently scoped for development by the Government & Mayur Resource Ltd.

Non-renewable resources consist of mineral, oil and gas resources. Once these resources are dug up out of the earth, the flow stops because these are non-living resources. A number of mines in the past and today produce gold, copper and nickel.

Previous gold and copper mines were Panguna Copper Mine on the island of Bougainville, Misima Gold Mine in Milne Bay Province and the Ok Tedi Copper Mine in Western Province. All



three mines are now closed. Mines that remain open today are the Porgera gold mine in Enga Province, the Lihir and Simberi gold mines in New Ireland Province and the Wafi Golpu Gold Mine in Morobe Province. The Krumbukari Nickel mine in Madang produces nickel for export.

Oil resources are currently produced in Hela and Southern Highlands Provinces. Oil reserves are pumped up from the earth's crust and transported to a refinery in Lake Kutubu, Southern Highlands Province. The processed oil is transported through oil pipes to the Kumul platform in the Gulf of Papua for export. Gas production is based out of Hela and Southern Highlands Provinces. Gas, like the oil, is pumped up and out of the earth's crust and piped in a pipeline connecting Hela and Southern Highlands Provinces, through the Gulf Province and through to Central Province for processing.

In PNG all non-renewable resources are fully exploited by foreign companies because they have the technology. The government collects taxes from these companies as revenue to carry out development work. Two main issues need to be addressed in the non-renewable sector are pollution from mining waste and good use of revenue.

LESSON 25A – Junior Primary

Name of Lesson: Exploiting Natural Resources.

Objective: By the end of this lesson, students can:

- Define natural resources.
- Make the connection between natural resources and economic growth.

Key Knowledge:

1. Natural resources are things that are found in nature and used by people.
2. Many resources used by people are renewable.
3. There are also non-renewable resources.
4. The world's natural resources are being misused by people.

Materials Needed: Flash cards with instructions for four groups, posters of logging, mining and other extractive activities.

Preparation: Prepare the flash cards with the group activity a day before the lesson. Put up posters of extractive activities on the blackboard before the lesson starts. Students are to work in groups.

Activity: Exploiting Natural Resources – Introduce the term natural resources on the blackboard and discuss what it is *i.e. things that are found in nature and used by people*. Explain that natural resources can be renewable or non-renewable. Renewable resources are able to renew themselves while non-renewable resources are not able to renew themselves. However, for renewable resources to renew themselves, they need time and less human interruption. This is the biggest threat because humans are not giving enough time to renewable resources to renew themselves.

Group discussion: In what way(s) are humans not giving enough time to natural resources to renew themselves? Give each group time to discuss the question. Make notes of their responses on the blackboard.

Explain to the class that one way in which humans fail to give enough time for natural resources to renew themselves is through exploiting (abusing or misusing) them at an increasing rate. Introduce the term *exploitation* and discuss what it is *i.e. exploitation refers to the act of unfairly using or developing resources for the benefit of something*. Brainstorm on what increased exploitation can do to natural resources. Make notes on the blackboard. For example, increased exploitation leads to decrease in important resources such as food and water.

Evaluation/Homework: Remind students that natural resources can be exploited for human needs. For homework, list two activities that lead to exploitation of resources.

LESSON 25B – Junior Primary (*Recommended for Grade 5*)

Name of Lesson: Exploiting Natural Resources

Objective: By the end of this lesson, students can:

- State that exploitation of natural resources is the use of natural resources for economic growth.
- Describe the consequences of exploitation of natural resources.
- Explain the reasons for increase in the exploitation of natural resources.

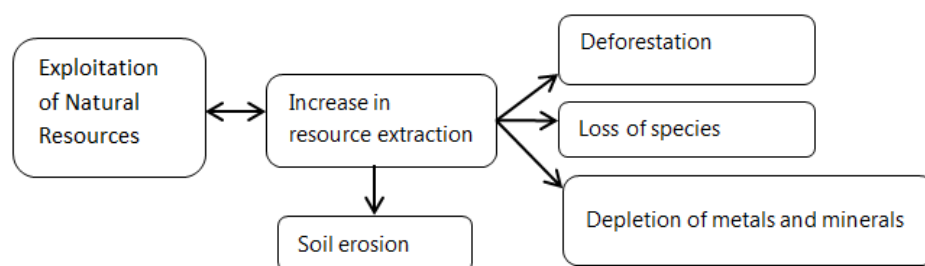
Key Knowledge:

1. Natural resources are exploited for economic purposes.
2. Excessive exploitation of natural resources results in problems such as deforestation and extinction of species.
3. Natural resources are under pressure.

Materials Needed: Flash cards with instructions for four groups, posters of logging, mining and other extractive activities.

Preparation: Prepare the flash cards with the group activity a day before the lesson. Put up posters of extractive activities on the blackboard before the lesson starts. Students are to work in groups.


Activity: Exploiting Natural Resources – Review the term *exploitation* and discuss it as in the previous lesson. Brainstorm on what increased exploitation can do to natural resources, how natural resource are exploited, why they are exploited and how this affects the environment and people. Allow for discussions and presentations. Make notes on the blackboard as shown below:



Discuss the effects of increased exploitation on natural resources as shown above. Emphasise that more natural resources are being depleted at a faster rate than in the past.

Tell your students that the increase in exploitation of natural resources is also enhanced by;

- a. Over population
- b. Inefficiency in resource utilisation
- c. Overconsumption
- d. Poverty
- e. Ineffective Structures (e.g., Human Institutions, Regulations and Attitudes), and
- f. Increase in sophisticated technology including machinery that enable more natural resources to be extracted quickly.



Divide class into four small groups. Assign each group with a letter name: A, B, C, or D. Give each group a flash card that contains instruction for their group activity. That is:

Card A – Suggest two ways to reduce the effects of mining on loss of species.

Card B – How can deforestation from exploitation be reduced. Suggest two ways.

Card C – Suggest two ways through which minerals like gold and copper could be prevented from being depleted.

Card D – How can soil erosion from exploitation be reduced? Suggest two ways.

Allow group discussions where students should appoint a scribe to record their points. Groups can also appoint a speaker to report their responses to the class.

Tell the class that all effects of exploitation can be reduced or prevented from happening. Different groups of people including communities, NGOs, and different levels of government can take their own measures to address these. Of importance is the awareness to different interested groups so that they can decide the best measures to take.

Note: Encourage further discussion on what the Government can do to ensure that exploitation of natural resources is reduced.

Evaluation/Homework: Remind students about the threat to natural resources when they are over exploited. For homework, students can list three key actions the Government can take to reduce or prevent exploitation of natural resources from harming plants, animals and people.

LESSON 26A – Senior Primary

Name of Lesson: Exploitation of Natural Resources – Taking Action.

Objective: By the end of this lesson, students can:

- Recognise the relationship between economic growth and natural resources
- Suggest ways to reduce the consequences of exploitation
- Create posters to prevent against exploitation of natural resources

Key Knowledge:

1. Exploitation of natural resources increase as economic growth increases.
2. Excessive exploitation of natural resources results in deforestation, species extinction and depletion of non-renewable resources.
3. Natural resources are under great stress and need protection.

Materials Needed: Flash cards, posters of logging, mining and other extractive activities.


Preparation: Write new terms on the flash cards. Write the questions for group work on the cards the day before. Put up posters of extractive activities on the blackboard before the lesson starts. Students are to work in groups.

Activity: Taking Action against Exploitation - Put up flash cards of the terms *exploitation*, *natural resources* and *economic growth* on the blackboard. Brainstorm on what these mean and make note of students' responses on the blackboard.

Tell the class that *exploitation* is a term that refers to the *act of unfairly using or developing resources for the benefit of something*. Natural resources refer to *all the useful things found in nature*. Explain that exploitation of natural resources for economic growth means to take advantage of useful things in the environment for financial development or wellbeing of a community or country.

Divide class into four groups. Assign each group a letter: A, B, C, and D. Give each group a flash card with a corresponding letter. They are to discuss the questions provided on each of these flashcards. For example:

- A. Explain the relationship between natural resources and economic growth. Why is this important?
- B. Discuss two reasons why exploitation of natural resources is increasing rapidly. How is this affecting the environment?
- C. In what ways can the effect of exploitation on the environment be reduced? Suggest two ways.
- D. Differentiate between renewable and non-renewable resources. Suggest two ways that these resources can be protected.



Each group will present their answers to the whole class for further discussions.

Tell the class that natural resources are not there to be exploited for human wellbeing. They also have the right to exist, particularly the plants and animals. In addition, natural resources must be sustainably used so that future generations can continue to use these resources.

Each group will create a poster or brochure telling people to use natural resources sustainably. The completed posters/brochures are to be used to carry out community awareness.

Arrange for the class to present these postures and brochures during community day. Each group should appoint their speakers and have pre-briefing on what each of them will say. Make sure to obtain permission from the School administration and board before the class does the awareness to the community.

Evaluation/Homework: Ensure groups complete their poster or brochure. This is to be used during another lesson for community awareness in the community.

Assessment Activity: This is an assessable activity. The assessment is both informative and summative therefore you have many different ways to assess this activity. Use a set of criteria to help you in assessing this activity.

LESSON 26B – Senior Primary

Name of Lesson: Exploitation of Natural Resources – Debate.

Objective: By the end of this lesson, students can:

- Present arguments for and against exploitation of natural resources.
- State that excessive exploitation of natural resources for economic development can be harmful to the environment and people.

Key Knowledge:

1. The country's economy is increasing at the expense of natural resources.
2. Excessive exploitation will result in depletion of natural resources.
3. Natural resources must be protected and sustainably managed.

Materials Needed: A stopwatch or clock, coloured flash cards to indicate different times, biros, notebooks, markers.

Preparation: This is a whole class activity which may take two lessons. Appoint a chairperson, a timekeeper, and three judges including the teacher as the chief judge. Put the topic on the board or a chart paper so the class can read it together.

Activity: Debate – Inform the class that this lesson will be a debate for and against the statement "*Natural resources must be protected from over exploitation*". Explain the activity clearly to the class ensuring that your instructions are very clear as to what students are expected to do in that lesson.

Divide the class into two big groups. Ensure that each group appoints three students to speak. Each of these six speakers can decide who will go first, second and third for their groups. Put forward the topic for debate: "*Natural resources must be protected from over exploitation*".

Come up with a way to decide which group will argue for the topic and the group that will argue against it. Have each group brainstorm on their key ideas and supporting points. The points should be noted by each of their presenters. The chair person will control the debate. The time keeper will keep the time. Each speaker will be given only three (3) minutes to speak. The teacher and selected students can act as judges.

Evaluation/Homework: Remind students of the importance of natural resources and the need to protect them against exploitation. For homework, ask the students to write an argumentative essay that is in line with the debate topic.

Assessment Activity: The debate and the essay tasks are assessable activities. For the debate, you can record each group's performance. For the essay, you can record each student's writing skills. In both cases, you need to design and develop your own assessment task using a set of criteria.

UNIT 6: CONSERVING & MANAGING OUR NATURAL ENVIRONMENT




Soro point, Lake Kutubu outlet, SHP. Photo/kyaro@WWF/2015

Introduction

The Kikori River Basin resources must be protected, conserved and managed for the benefit of future generations.

Conservation means protecting and reserving natural resources for sustainable use for now and for future. The concept of sustainability in conservation allows the exploitation of environments at levels that cause no long-term harm. For example, if logging is sustainable, then the removal of trees from forests will not harm the overall function of the forest. The other animals and plants that live in the forest will not be put at risk by the logging. In sustainably logged forests, the rate of growth and replenishment of the forest is equal to or greater than the rate at which trees are removed. Sustainable logging will also have no impact on other ecosystems like the rivers, lakes and seas to which the forests are connected by water movement. Actions that compromise this sustainability will jeopardise the existence of healthy ecosystems, habitats and plants and animal species.

Students must take an active role in exploring their local environment in order to understand different components and elements of the environment and the interdependence of organisms for their survival. They will learn about the way people and other living organisms depend on



the environment through observation, gathering information and presenting findings, making posters and poems, etc. The findings will assist students to develop positive attitudes such as caring, accepting, respecting, appreciating and other virtues in order to ensure that the local environment is protected and preserved and managed for future generations.

TOPIC 1: TRADITIONAL AND MODERN CONSERVATION PRACTICES

1. Traditional Conservation Practices

Traditional conservation has always been practised from generation to generation in traditional societies in Papua New Guinea. The concept of traditional conservation was important as a way of life and about how resources were used and managed in many traditional societies. This practice had existed long before Papua New Guinea became fully aware of the consequences of overharvesting its resources due to population growth. Traditional conservation practices basically evolved around the rules and principles established by each society for its people to follow.

For example, clan and tribal rules on land allocation or use of forests and fishing rights by the Australian Aborigines may be different to the New Zealand Maori or the Solomon Islanders or Vanuatu and PNG.

Papua New Guinea has clans and tribes that own the land and from there, social systems of conservation are organised. There are two ways of land ownership, patrilineal and matrilineal. Patrilineal societies own and pass on land through fathers and matrilineal systems through their mothers.


Land is life because the land contains the forests, rivers, lakes, coastal beaches, islands and coral reefs that people use for their everyday living.

Traditional conservation practices have evolved from one society to another and to the current generation. Modern conservation practices have added advantage to the traditional conservation practices, too. This is discussed below.

2. Modern Conservation Practices

The global environmental conservation effort takes its mandate from the International Union for the Conservation of Nature (IUCN). The IUCN was established in 1948 in Switzerland. The IUCN is an international organization working in the field of nature conservation and sustainable use of natural resources. It was the IUCN that established the World Wildlife Fund for Nature (WWF) in 1961 as a complimentary organisation to focus on fund raising, public relations and increasing public support for nature conservation.

Most environmental challenges are global issues. Recognising this, the IUCN sets multi-lateral environmental agreements (MEA) which are intergovernmental documents intended as legally binding with a primary purpose of preventing or managing human impact on natural resources.



Countries in the world are invited to implement the MEA. When ratified, the country is responsible for implementing the goal at their local level.

Each country is responsible for setting their conservation goals based on their conservation challenges. The idea is that a sum of local efforts will result in a global change. For example, the 4th Goal in the PNG Constitution sets the criteria for conservation in PNG. The 4th Goal is a response to the fact that PNG is a rural country where most of its people depend on the environment to maintain a livelihood. Consequently, the 4th Goal is about protecting natural resources and the natural environment for the benefit of all. It states:

“Our natural resources and environment to be conserved and used for the collective benefit of us all and are replenished for the benefit of future generations”.

The 4th Goal gives the mandate for conservation, but it can also serve as a scorecard against which effectiveness in conservation efforts can be measured. A successful and effective conservation project should have these characteristics;


1. That natural resources are conserved and used for collective benefit.
2. That natural resources are protected and left to replenish for the future generations.
3. That natural environment is conserved for collective benefit.
4. That natural environment is left protected and intact for future generations.

Every country has a designated national authority (DNA) for implementing conservation efforts. In Papua New Guinea, Conservation and Environment Protection Agency (or CEPA) (formerly Department of Environment and Conservation or DEC) is the designated authority to fulfil the mandate of the 4th National Goal.

The environmental programs in PNG were already up and running for about two decades since independence when the Kikori River Basin (KRB) came into being in the early 1990s. To appreciate the challenges in the Kikori River Basin (KRB), it is imperative to understand two things that have shaped the WWF project to what it is today. First, is to understand the history of the conservation efforts of the country so far because that history and the way of doing things affected the WWF in the Kikori River Basin. Second, the WWF history in the KRB is intertwined with the story of the oil and gas industry in the country.

Protected Areas in Papua New Guinea

The protected areas are established by several environmental laws - Fauna Protection (and Control) Act 1974, National Parks (Act) ordinance 1966-1971, Sanctuaries and Fauna Protected Area Act (1966) and Conservation Areas Act 1980. Under these laws the following protected area types are established; the Wildlife Management areas (WMA), now changed to Community



Conservation area (CCA) under new Protected Areas Policy. The next is National Parks, Sanctuaries & Memorial Parks. In total, there are currently 56 Protected Areas (PA) in PNG. Of these 33 are Wildlife Management Areas (WMA) established under the Fauna Protection (and Control) Act 1974 while the rest are National Parks, Sanctuaries and Memorial Parks, established under the (now repealed) National Parks (Act) ordinance 1966-1971, the Sanctuaries and Fauna Protected Area Act (1966), and the Conservation Areas Act 1980.

Modern conservation practices include community conservation areas, national forest reserves, nature parks, marine parks, nature reserves, zoos and locally managed marine areas. These areas are governed by scientific facts and studies that confirm their importance as conservation areas. Modern conservation addresses population growth, because as more and more people are added, natural resources still remain the same.

Role and functions of different Protected Area Systems

1. Wildlife Management Area (WMA) or Community Conservation Area (CCA)


The lowest conservation unit recognised by law in PNG is the WMA. WMA is now changed to Community Conservation Area under the new Protected Area Policy. The WMA is implemented by local people on their own land. The establishment of WMA's under the Fauna Protection Act (1974) was seen as a solution to achieving conservation in the complex land tenure environment. WMA recognises indigenous people as owners of the land and the biodiversity within and gives them the role of managing their own wildlife. Landowners form committees and make management rules as well as set appropriate penalties for offenders. Furthermore, the interpretation of "land" in the Fauna Protection Act (1974) refers to both aquatic and terrestrial environments; as such the WMA's have been extended to protect marine resources.

Although, WMA legislation refers strictly to wildlife, the rules made by the management committee are not restricted to fauna conservation but extended to other natural resources, including plants. WMA is compatible with PNG customs being flexible with high level of control by landowners, but whether WMAs are effective in achieving conservation is yet to be analysed (e.g. Shearman et al 2008).

2. The National Parks

The word 'Park' comes from the Medieval Latin *parricus*, which means 'enclosure'. 'Reserve' also originates from the Latin *reservare*, meaning 'save'. Indeed, 'preservation', 'protection', and 'conservation' essentially imply that certain areas or natural aspects are kept away from the present demand. Similarly, 'establishment' denotes a legal event of bringing into existence and 'management' implies certain techniques of supervising the area, frequently involving a whole range of new institutions, professionals and methods.

Parks and reserves are for the 'common good', established and managed through 'impartial' state institutions.



The prime objective of national parks is conservation. The forests vegetation of parks provide many important benefits to the environment such as shelter for all species living on land, through carbon sequestration to combat global warming and climate change. Forests also contribute a lot in moderating local and regional rainfall distribution and intensity. In addition, forests have medicinal, aesthetic and recreational values apart from serving as sources for food, clean water, and air which benefits millions of people.

3. The Nature Parks

The nature parks have similar role as the national parks. Nature Parks and other conservation reserves are essential for the success of our efforts to protect our national heritage for future generations. Parks contribute greatly to our enjoyment and to the physical and mental wellbeing of the community. They also benefit the economy.

4. The Wildlife Sanctuaries

A wildlife sanctuary is an area where animal habitats and their surroundings are protected from any sort of disturbance. The capturing, killing and poaching of animals are strictly prohibited in these regions. They aim at providing a comfortable living for the animals.


Tourism is not permitted in a wildlife sanctuary. People are not allowed unescorted there. The main objective of establishing a wildlife sanctuary is to educate humans on how to treat the animals. The animals are taken care of and allowed to live peacefully in their natural habitats.

There are a number of reasons for establishing wildlife sanctuaries. Some of these are listed below:

- To protect endangered species.
- It is quite difficult to always relocate the animals from their natural habitat; therefore, protecting them in their natural environment is advantageous.
- The endangered species are specially monitored. If they reproduce and grow in number while under protection, few specimens can be kept for breeding in the conservation parks for their survival.
- Biologists, activists and researchers are permitted in the wildlife sanctuaries so that they can learn about the animals living there.
- A few sanctuaries take in injured and abandoned animals and rehabilitate them to health before releasing them back into their habitat.
- To preserve the endangered species and protect them from humans and predators.

5. The Nature Reserves²⁴

²⁴ https://en.wikipedia.org/wiki/Nature_reserve



A nature reserve (also known as a natural reserve, wildlife refuge, wildlife sanctuary, biosphere reserve or bio-reserve, or nature conservation area), is a protected area of importance for flora, fauna, or features of geological or other special interest, which is reserved and managed for purposes of conservation and to provide special opportunities for study or research. They may be designated by government institutions in some countries, or by private landowners, such as charities and research institutions. Nature reserves fall into different IUCN categories depending on the level of protection afforded by local laws. Normally it is more strictly protected than a nature park. Various jurisdictions may use other terminology, such as **ecological protection area** or private protected area in legislation and in official titles of the reserves.

6. The Marine Parks

A *marine park* is a park consisting of an area of sea (or lake) sometimes protected for recreational use, but more often set aside to preserve a specific habitat and ensure the ecosystem is sustained for the organisms that exist there. Most marine parks are designated by governments, and organized like 'watery' national parks.

The largest marine park used to be the Great Barrier Reef Marine Park in Australia, at 350,000 km² until 2010, when the United Kingdom announced the opening of the Chagos Marine Park or Chagos Archipelago.

Although for many uses it is sufficient to designate the boundaries of the marine park and to inform commercial fishing boats and other maritime enterprises, some parks have gone to additional effort to make their wonders accessible to visitors. These can range from glass-bottomed boats and small submarines, to windowed undersea tubes.

In New Zealand, a marine reserve is an area which has a higher degree of legal protection than marine parks for conservation purposes. In New South Wales, Australia, there are planned marine parks which will stretch along the coastline of the entire state.

7. The Zoos

Early zoos collected wild animals from around the globe to showcase the strange and unusual creatures from far corners of the earth. Welfare and husbandry were severely lacking, but so was biological knowledge, and people thought the world and its animals were limitless. Today, zoos have had to modernise to keep up with changing social and cultural values. Modern zoos generally have exemplary husbandry and welfare standards, and more and more they project themselves as pinnacles of conservation. With wildlife and their habitats on the edge of extinction around the globe, many species now occur much more abundantly in captivity than in the wild.

Sanctuary Zoos - The sanctuary Zoos serve as a sanctuary for the thousands of animals injured, abused or otherwise damaged by the booming captive wildlife trade.

Education - Zoos are here to educate the next generation so that they will grow up inspired by wildlife and learn to respect it.

Fundraising - Zoos support a number of in situ conservation projects and contribute to valuable research and practical conservation efforts worldwide.

Genetic Backup Plan - Zoos are there to maintain the genetic vigor of a species as it dwindles in the wild, so that one day they can be reintroduced.

8. Locally Managed Marine Area (LMMA)

LMMA's are form of Marine Protected Area. They are marine reserves, fully protected marine areas, no-take zones, marine sanctuaries, ocean sanctuaries, marine parks, and locally managed marine areas, to name a few. Many of these have different levels of protection, and the range of activities allowed or prohibited within their boundaries varies considerably too.

Why do we need Marine Protected Areas?

- Maintaining biodiversity and providing refuges for endangered and commercial species.
- Protecting critical habitats from damage by destructive fishing practices and other human activities and allowing them to recover.
- Providing areas where fish are able to reproduce spawn and grow to their adult size.
- Increasing fish catches (both size and quantity) in surrounding fishing grounds.
- Building resilience to protect against damaging external impacts, such as climate change.
- Helping to maintain local cultures, economies, and livelihoods which are intricately linked to the marine environment.

Conservation in the Kikori River Basin.

Since 1995, WWF's work in Kikori River Basin had resulted in establishment of five Wildlife Management Areas (WMAs) with a total of 107 059ha protected forest areas.

Table 1 List of Wildlife Management Areas in Kikori River Basin

Name	Area (Hac.)	Date	Prov.	District	LLG
Sulamesi WMA	86,451.00	7-Feb-08	SHP	Nipa Kutubu	Mt Bosavi Rural
Libano-Arisai WMA	3,964.00	7-Feb-08	SHP	Nipa Kutubu	Mt Bosavi Rural
Libano-Hose WMA	7,736.00	7-Feb-08	SHP	Nipa Kutubu	Mt Bosavi Rural
Lake Kutubu WMA	4,924.00	25-Jun-92	SHP	Nipa Kutubu	Lake Kutubu Rural
Neiru (Aired Hills) WMA	3,984	24-Dec-87	Gulf	Kikori	East Kikori Rural

Mount Bosavi is one of the great unknown bioregions - a dormant volcano crater which is rich in biodiversity and has a landscape that deserves protection. Mount Bosavi hosts three WMA's; the Sulamesi WMA is on Eastern side of the Mt Bosavi Crater and closer to the Kikori and the Western Border, while Libano Hose and Libano Arisai WMA are on the Western side closer to Hela Province.

The Sulamesi WMA is established on the customary lands of the Kosua people. The Libano Hose and the Libano-Arisai were inspired by the Sulamesi WMA. These WMAs were gazetted in 2008.



Fig. 34 Mt Bosavi hosts three WMAs.

Facts about Mt. Bosavi;

- ❖ Unknown bioregion.
- ❖ Collapsed cone of extinct volcano with rich biodiversity.
- ❖ Crater is 4km in length and 1km deep.
- ❖ Last eruption: 200,000 years ago.
- ❖ Located on Great Papuan Plateau.
- ❖ Four (4) cultural linguistic groups: Kaluli, Ologo, Walulu & Wisesi.
- ❖ BBC discovery in 2009: 40 undescribed species, 16 frogs, 3 fish, several insects and spiders, a bat, and a giant rat (82 cm and weighs 1.5 kg).

Lake Kutubu is a freshwater lake in limestone karst country. It stands at 800m above sea level and covers approximately 1,000 hectares of swamp forest and upland tropical forest. The WMA and Ramsar share the same boundary. The main focus for Lake Kutubu WMA was to protect fish which is a source of food for the local people, while WWF wanted to conserve the lake's unique landscape and biodiversity. These goals were compatible enough to develop an effective partnership to meet both aspirations. Most effort was put into Lake Kutubu because of the presence of oil and gas. The Oil Search funded NGO, Community Development Initiative (CDI), established in 2001 is based at Lake Kutubu and carries out community development projects around the Lake area.



Fig. 35 Lake Kutubu Ramsar Site & Wildlife Management Areas

Facts about Lake Kutubu;

- Clear fresh water lake with 12 endemic fish species. Stands at 800m above sea level
 - Approx. 1,000 ha of swamp forest and upland tropical forest.
 - 4,924ha Wildlife Management Area. 25,000 ha catchment area.
 - WMA committees implement Catchment management plan

The Kikori Delta has only one WMA - the Neiru (Aired Hill) WMA. The Neuri (Aired Hills) WMA was initially established in December 1987 and is managed by members from the Ero and Wowou villages belonging to the Porome tribe in the Lower Kikori area. The Neiru (Aired Hills) WMA is series of 11 hills rising from the Kikori Delta to a height of 300m above sea level on the Kikori River delta. Apart from the tropical hardwood and biodiversity, the Aired Hills is a site of archaeological importance. The hills contain the evidence of the early Hiri trade. The Neiru (Aired Hills) WMA is one of the oldest WMA in the country.

Kikori River Basin UNESCO World Heritage Site *Tentative List*

The World Heritage List recognizes the most important examples of cultural and natural heritage globally. World Heritage areas are a legacy to all people of the world and their outstanding universal values are protected for future generations. World Heritage Sites are places that are important to and belong to everyone, irrespective of where they are located. They have universal value that transcends the value they hold for a particular nation.

The United Nations Educational, Scientific and Cultural Organization (UNESCO) is a specialized agency of the United Nations (UN). The UNESCO seeks to encourage the identification, protection and preservation of cultural and natural heritage around the world considered to be

of outstanding value to humanity. This is embodied in an international treaty called the Convention concerning the Protection of the World Cultural and Natural Heritage.

Therefore, Kikori River Basin was identified and nominated as a UNESCO World Heritage Site *Tentative List* in 2006. The Kikori River Basin having the *Tentative List* is a pre-qualification to be nominated as a WHS Property status in the future. This is also indicating international significance of conservation areas in the region.



Fig.36 Map of Kikori River Basin UNESCO WHS Site Tentative List

The Kikori River Basin:

- 2.3 million ha of virgin tropical rainforest. Covering 6% of the landmass of PNG.
- A designated Ramsar site (Lake Kutubu, SHP).
- The biggest and most fragile and critical ecosystem of the country
- 5 distinct eco-regions, 12 bio-regions.
- 373,252 populations of 16+ ethno-linguistic groupings.
- 15,000-21,000 higher plants. 3,000 species of orchids. 800 species of coral.
- 600 species of fish, including 12 endemic species.
- 250 species of mammals, including a woolly giant rat.
- 760 species of **birds**, incl. the world's rarest cave roosting bird
- 8 species of **tree kangaroos**, 84 genera of animals are endemic

WWF is working with stakeholder partners to have Kikori River Basin fully recognised or nominated as a UNESCO WHS Property status. By having the KRB as a UNESCO WHS property status can provide higher level protection through international conventions such as the Convention concerning the Protection of the World Cultural and Natural Heritage (the World Heritage Convention).

LESSON 27A – Junior Primary

Name of Lesson: Traditional Conservation Practices.

Objective: By the end of this lesson, students can:

- State one traditional law about fishing or hunting.
- Describe at least one traditional conservation method used by the local people.

Key Knowledge:

1. Importance of traditional harvesting practices.
2. Traditional laws about fishing and hunting.

Materials Needed: Note books, pens, pencils, coloured markers, pencils or crayons, used cardboards, poster or butcher papers.

Preparation: Invite a community elder to talk to the class before the lesson. Prepare several questions and give to the class so that they can ask the community leader.

Activity: Class Discussion – To begin the lesson, brainstorm by asking the class to share any information about how their people use their environments to obtain resources in the past and present. Allow the students to orally share their knowledge. Then tell them that in this lesson they will be hearing from an elder in the community about how their people have accessed and used resources in the past. Introduce the elder to the class.

The students listen to the talk by the elder and then they can ask questions. You can help the class by preparing a set of questions that you can give to different students to ask the elder. For example:

- (i) How did people know that they have collected enough fish or bush meat?
- (ii) What kind of tools did the people use in the past to fish or hunt?
- (iii) What were some laws about hunting, fishing or gathering resources that people practiced in the past? Are some of these laws useful today?

After the talk, ask the class to work in six groups to write up one traditional law or rule about using resources. This should be written on butcher or chart paper. Have an artist in the group to draw their picture and colour it. This should then be presented to the rest of the class in the next lesson.

Evaluation/Homework: Ask the class to verbally state one or two traditional laws about resource use that they have learnt. For homework, they can complete their traditional law poster.

LESSON 27B – Junior Primary

Name of Lesson: Modern Conservation Practices.

Objective: By the end of this lesson, students can:

- Appreciate the modern conservation practices that protect natural resources.
- Explain what protected area is.

Key Knowledge:

1. Importance of modern laws.
2. Protected areas are set up to protect natural resources.

Materials Needed: Note books, pens, pencils, coloured markers, pencils or crayons, used cardboards, poster or butcher papers, songs and poems, musical instruments.

Preparation: This activity may take up to two or more lessons to teach.

Activity: Class Discussion - Have a class discussion by asking students to name some of the important plants, animals and landscapes and seascapes. Make note of students' responses on the blackboard. Their responses should include the Kikori River Basin and the natural resources there. Ask the class to discuss the following in their respective groups:

1. Should the government protect these natural resources and landscapes or seascapes?
2. How do you think the government can do that? Suggest some ways.

Tell the class that the government has taken some actions in protecting these resources. It has put in place laws such as the Fauna Protection and Control Act, Environment Act and Protected Area Policy. The government has also set up protected areas in the country to protect these resources. Explain that a protected area is an area set up by the Act of Parliament to protect important plants, animals and landscapes or seascapes.

As a class activity, ask the class if they know of a protected area in their province or the nearby province. Give the class an opportunity to discuss in their groups and report back. Make notes of their responses. Some examples they can mention are the Lake Kutubu Wildlife Management Area, Neiru WMA, Libano WMA, Arisai WMA and Sulamesi WMA.

Evaluation/Homework: Remind the class about the importance of the modern laws set by the government that are helping to protect the natural resources of the country. For homework, they can find out more about protected areas and how these protect natural resources.

LESSON 28A – Senior Primary

Name of Lesson: Learning from Traditional Conservation Practices.

Objective: By the end of this lesson, students can:

- Appreciate the benefits of traditional conservation practices through an interview.
- Describe an example of a traditional conservation practice.

Key Knowledge:

- Significance of traditional conservation practices.

Materials Needed: Note books, pens, pencils, survey questions.

Preparation: This activity will take two lessons to complete. Prepare the interview questions for the class a day or two in advance. Ensure the class is divided into six to eight small groups for the interviews.


Activity: Interviews – Begin the lesson by asking the class if they know how their people have obtained and used resources in their environment. Allow some time for brainstorming exercise in their discussion groups. Then have each group report their responses. Make notes on the blackboard.

Tell the class that they will interview elders and community members to find out more about traditional conservation practices. Distribute *Activity Sheet 6.1* and explain the questions to the class. Tell the class to carry out interviews in small groups so that they can interact with the community members.

Give time for students to interview the community member or elder their group has chosen. Have them complete the interviews and write up their report. Discuss the feedback from each group report through class discussion. Group feedback should show some examples of useful traditional conservation practices for today's society.

Evaluation/Homework: Remind students about the importance of traditional conservation practices in terms of resource use. For homework, the students can complete their group reports.

Assessment Activity: This is an assessable activity. You can assess your students' work by writing a set of criteria that will help you to fairly mark their reports.



Activity Sheet 6.1 – Community Interview

Use the following questions as guide to interview a community member or elder.

1. Can you describe the kind of environment the local people lived in 20 years ago?
2. What kind of natural resources did the people access from their environment?
Please name some of these.
3. How often did the people access these natural resources?
4. Did they have some rules or laws about when or how much of these resources they can take out? If yes, can you give an example?
5. How did the people come up with these rules or laws?
6. Were these rules or laws useful?
7. Do you have any suggestion on how these rules or laws can be applied today?

LESSON 28B – Senior Primary

Name of Lesson: Making use of the Modern Conservation Practices.

Objective: By the end of this lesson, students can:

- Describe the benefits of modern conservation practices.
- Explain the purpose and role of protected areas.
- Write an argumentative essay.

Key Knowledge:

1. Importance of modern conservation practices.
2. Protected areas are vital for protection of different kind of species and their homes.
3. Country specific actions are necessary to protect different kind of species and their homes.

Materials Needed: Note books, pens, pencils, pictures of flagship species of KRB.

Preparation: This activity may take up to two or more lessons to teach. Have students divided into 6 working groups.

Activity: An Argumentative Essay - Have a display of pictures of the flagship species of the Kikori River Basin i.e. Pignose Turtle, Inshore Dolphin and Tree Kangaroo. Ask the class to do the following in their work groups:

- (1) Choose one of the flagship species and discuss why it is important to the region.
- (2) Discuss how this species can be protected from being overhunted or harmed through environmental destruction.


Groups present their responses. Make note of these on the blackboard. Tell the class that there are laws made by the government to protect different kind of species and their habitats from being harmed. Two examples of these laws include:

1. Fauna Protection (and Control) Act (1974)
2. Conservation Areas Act (1980)

Explain that the Fauna Protection (and Control) Act 1974 is aimed at protecting important species although it does not protect their homes. On the other hand, Conservation Areas Act 1980 is useful as it protects both species and their habitats. These laws are also important as they help to set up protected areas in the country to protect the special species.

Tell the class that each student will need to write an argumentative essay. To do this, they should follow the steps below:

1. Choose one of the above Acts of Parliament i.e. Fauna Protection (and Control) Act 1974 or the Conservation Areas Act 1980.
2. Study the description provided on this Act.
3. Identify two important advantages of this Act.
4. Say how the Act will benefit the flagship species of Kikori River Basin.

- 
5. Do an outline of the essay.
 6. Write the essay highlighting these benefits on the flagship species.

Students can discuss their points together for clarity. However, each student must write up their own essays.

Evaluation/Homework: Remind the class about the two important Acts that protect special species and their habitats. For homework, provide guidance to the students to complete their essays before the next lesson.

Assessment Activity: This is an assessable activity. You can assess your students' work by writing a set of criteria that will help you to fairly mark the activities. The essay is an individual work so ensure that the criteria are very clear at the beginning of the writing process.



TOPIC 2: CONSERVING AND MANAGING THE RESOURCES OF KIKORI RIVER BASIN

The people of the Kikori River Basin represent a small-scale version of the issues faced by tribal peoples throughout Papua New Guinea. Increasing populations, the redistribution of people given recent increased development opportunities and the end of tribal warfare, the introduction of modern fishing and hunting technologies, and continued poor access to the cash economy have all intensified the pressures placed on natural resources.

Many tribal peoples co-exist in the Kikori region. Each tribe has its own social attributes and differs in their use of resources, in their attitudes to environmental values, and their perceptions and reactions to changes in the state of the environment. This complicates conservation efforts, which invariably rely upon community support and involvement.

However, in the early 1990, the USAID Biodiversity Program undertook a joint project to map biodiversity hotspots in PNG in a program called the Conservation Needs Assessment (CNA). The assessment aimed to map natural and cultural areas that have significant conservation values. This study identified KRB as an important area for natural and cultural heritage for the protection and sustainable management.

Following this study, WWF has rallied stakeholder support from local communities, provincial government authorities, Conservation & Environment Protection Authority (CEPA), Oil & Gas Industries, and ensured the establishment of four wildlife management areas (WMA) - Lake Kutubu, Libano Arisai, and Libano Hose WMAs. They comprise 107 59ha and were gazetted through CEPA. Further still, Lake Kutubu WMA was designated as a Ramsar Site, and WWF's work in progress is to have Kikori River Basin nominated as a UNESCO World Heritage Site Property from its current *Tentative List* status.

The presence of WWF in the KRB made the area one of the best-researched in PNG. About 50+ biodiversity research studies have been undertaken - some of them were published while others exist as grey literature.

After efforts to establish protected areas using local legislation or laws and reinforcing recognition of traditional conservation practices, the next challenging part is how effective these protected areas are managed for current and future generations. WWF has made some effort in supporting CEPA and local communities with development of protected areas management plans including some flagship management plans. That is, through Kikori Integrated & Conservation Development Programme, WWF supported the local capacity in community conservation development planning and management plan; provided support for alternative income livelihood projects such as eco-forestry, insect farming, vanilla and fish; eco-enterprises; eco-tourism (home-stay guest houses, bird watch & tour guiding); honey bee keeping, and micro-finance & savings schemes. These are all linked to annual Kutubu Kundu & Digaso Festival. These programmes are part of strengthening conservation areas management and development planning for the communities.

In the context below, we will discuss specific conservation management plans that are used in Kikori River Basin protected area systems to ensure that the natural resources within them are better managed.

The Kikori River Basin Conservation Blueprint – Landscape Level Land Use and Management Plan

A latest conservation effort by the WWF in Kikori River Basin has been in developing the Kikori River Basin Conservation Blueprint (KRB CBP)²⁵. The blue print was developed using GIS spatial planning tool called MARXAN. This tool uses key biodiversity targets or outstanding biodiversity values to make land use scenarios.²⁶ The outcome of this exercise provides guidance to future land use planning to balance conservation and environmentally destructive extractive industries such as logging, oil and gas as well as government infrastructure developments.

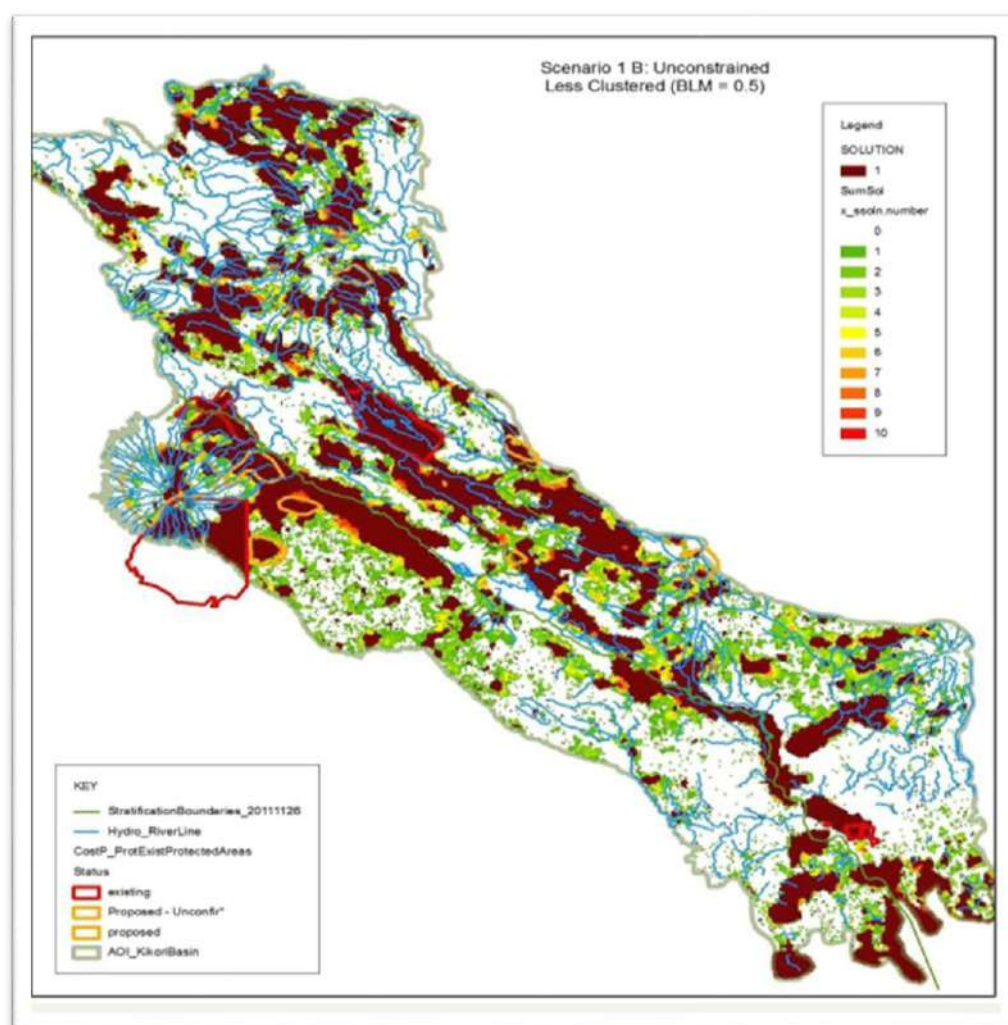


Fig. 37 The Kikori River Basin Conservation Blue Print map indicating high priority conservation areas ranked from 1-10. This map is generated based on 27 conservation targets.

²⁵ WWF, 2015 WWF 2015, The Kikori River Basin Conservation Blueprint

²⁶ Ardron et al (2010) Marxan Good Practices Handbook, Version 2. Pacific Marine Analysis and Research Association, Victoria, BC, Canada. 165 pages. www.pacmara.org.

The KRB CBP map provide overall guide for adoption by industries and government sectors from local level government to district and provincial government plans to incorporate in their five year development plans. Agriculture, forestry, mining and petroleum industries will use this blue print as a guide to plan their development projects to ensure that development does not jeopardise conservation. This is so that any economic development can have a balance with conservation and sustainable natural resource management principles.

The KRB CBP is being used to dialogue with government departments to lobby support and influence policy change and adoption of sustainable land use practices in respective land development sectors and industries. This blueprint would form the basis for future Community Conservation Areas in the KRB especially for pushing the KRB WH agenda.

The Wildlife Management Plan – Lake Kutubu

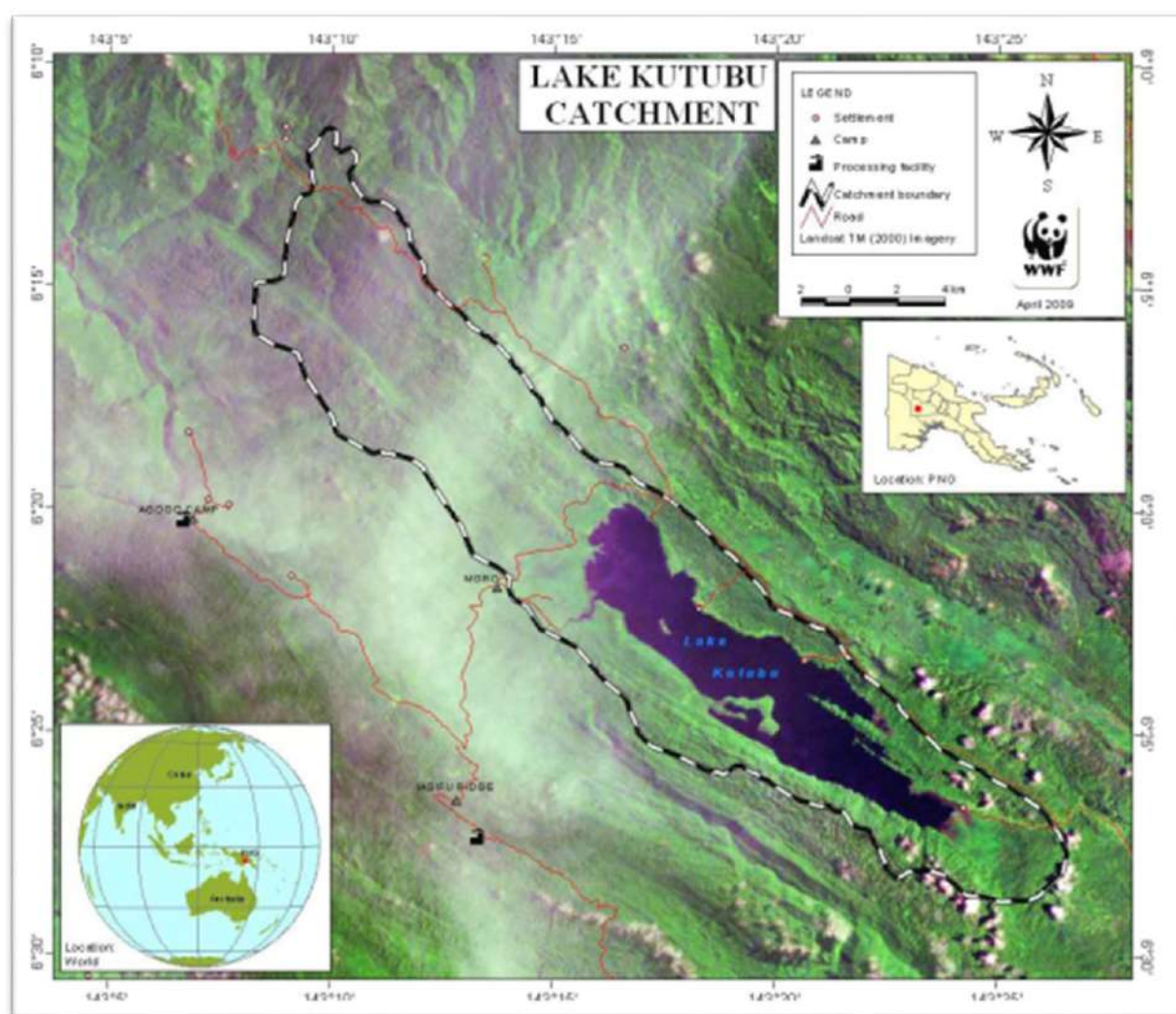



Fig. 38 Lake Kutubu Ramsar Site and Wildlife Management Area Catchment

In order to manage the natural resources and biodiversity and cultural heritages found within the protected areas, there has to be a management plan so that it guides the local committee in making informed decisions about how the resources found within the protected areas can



be used. The management plan reflects on the current trend on issues or the threats affecting the resource and the livelihood depended forest or coastal communities, and sets rules and guides for the local people to abide by in extracting and using the natural resources in a more sustainable manner.

Let's look at the case study on Lake Kutubu Wildlife Management Area.


Located in the Southern Highlands Province of Papua New Guinea, Lake Kutubu is PNG's highest freshwater lake. Its waters are exceptionally clear, which allows for high levels of primary production which, in turn, supports the most unique lacustrine fish community in the entire New Guinea – Australia region; the lake harbours 12 known endemic species of fish. The humid closed rainforest, which comprises much of the lake's catchment, is relatively undisturbed due to low human population, remoteness from major towns, and ruggedness of the karst landscape. The rich resources of the lake (water and fish) provide for the livelihood and well-being of the 2000-3000 people who live along its margin.

Key ecological, development and institutional concerns in the Lake Kutubu Catchment

Lake Kutubu is situated in a very vulnerable location where oil and gas operations are currently underway and set to expand in the future. Oil and gas activity has already resulted in a rise in the number of local people participating in the cash economy and an influx of settlers seeking employment and the peripheral benefits from these operations. Land development activities associated with the increasing influx of people into the area imposes an additional burden on the existing natural resources and brings with it an increased risk of the degradation of the natural environment e.g. from pollution, and the accidental or intentional introduction of invasive species. The development of the Liquefied Natural Gas (LNG) project had increase the deleterious impacts on the ecology and the biodiversity of the Lake Kutubu catchment through the opening up new areas of forest, and a further influx of settlers from other areas of PNG.

Within the Lake Kutubu Catchment, the demands on the water resource are likely to increase in the future with increasing population and land development. In order to meet these demands without jeopardising what we have, or indeed to improve things, we need to start thinking now in a more integrated way about how the waters of the catchment are managed.

Lake Kutubu lies in the upper catchment of the Kikori River, which has been described as one of the most intact and thus biologically rich environments in PNG, and in the Asia/Pacific region. Logging is a major economic activity within the Kikori Basin, downstream of Lake Kutubu. New access roads are being built within the Lake Kutubu Catchment, such as the road being constructed to link Samberigi to the Kikori road. Several other roads have already been built, including one that connects the Southern Highlands to Kikori in the Gulf Province. Another major works proposal is the construction of a wharf facility at the Kikori station. The increased road access had already led to the unregulated development of other small-scale



sawmill activities such as extraction of timber for local construction, harvesting (including hunting) of natural forest products, and clearing of forest land for homesteads and gardens. Catchment management planning is a relatively new concept in Papua New Guinea (PNG). Although the government through the Conservation & Environment Protection Authority (CEPA) has a concept in place for Total Catchment Environment Management Policy (TCEMP), its implementation is yet to be realized and currently steps are being taken by the government to make this concept a reality.

How can the Lake Kutubu Catchment Management Plan (CMP) assist in addressing these concerns?

WWF had assisted the Lake Kutubu WMA committee in developing a Catchment Management Plan. This plan supports the committee by identifying actions to stop the deterioration of the Lake Kutubu catchment, which could potentially have serious, long-term impacts on the habitat and activities in the downstream areas. The Lake Kutubu CMP provides direction for all stakeholder groups on the future management of the natural resources of the Lake Kutubu catchment. It identifies the major issues affecting the catchment and outlines strategic management actions to address each of the issues. The CMP also identifies responsibilities for undertaking actions, and proposes implementation arrangements and coordination mechanisms.

By providing a framework within which all relevant stakeholders can work together to resolve conflicts and manage the natural resources in the Lake Kutubu catchment in a sustainable manner. The CMP proposes a mechanism (the Lake Kutubu Catchment Management Forum, and Steering Committee) through which all stakeholders will be able to address conflicts and seek resolution especially in relation to issues that impact on more than an individual stakeholder group's interest. The net result is a more coordinated approach to the wise and sustainable use of the water resource of the Lake Kutubu catchment, based on the consensus and co-operation of all those with an interest in the resource.

By supporting the further development and implementation of PNG's "Total Catchment Environment Management Policy (TCEMP)". The development and implementation of this CMP will serve as a pilot project for catchment management in PNG and as a source of 'lessons learnt' to enhance the development of the TCEMP.

For any protected area (WMA, CCA, National Parks, sanctuaries or nature reserves or LMMA) will need a protected area management plan that guides the local committees and state to monitor and ensure the conservation values and livelihood needs are met. The management plan is a tool used to monitor management effectiveness of any protected area.

Flagships Species Conservation and Management Plan

The conservation of populations of threatened species is of great importance, particularly when the species also has high socio-economic value. For example, the Pig-nosed turtles

(*Carettochelys insculpta*) represent the sole surviving member of the family Carettochelyidae, now restricted in distribution to southern New Guinea and the Northern Territory (NT), Australia.

The Pig-nosed turtle is listed as Vulnerable (A1bd) on the IUCN Red List and as Near Threatened in PNG and the Northern Territory, as well as being listed on CITES Appendix II. Pig-nosed Turtles are an important source of protein for indigenous communities. However, market and village consumption data have been used to establish that populations of the Pig-nosed turtle in the Kikori River Basin have declined by over 50% in the 30 years since they were first monitored in 1981.




Fig. 39 Pig-nosed Turtle found in Kikori River Delta area.

Studies on the reproductive biology and patterns of exploitation of the turtles assist with identification of opportunities for effective responses to enable the Kikori communities to manage the resource sustainably.

The management plan aims to conserve in the wild the known populations of the Pig-Nosed Turtle in the Kikori River catchment, within a context of high and complex cultural diversity and the need for socio-ecological resilience. This means that management of the turtle should also aim to achieve sustainable use of the animal and its eggs as a food resource for residents of the catchment.

Accordingly, there needs to be a collaborative effort between conservationists, locals and government agencies to manage this species. WWF is coordinating management of the Pig-nosed Turtle in the Kikori River Basin with the involvement and cooperation of a broad range of stakeholders. These stakeholders include the Conservation and Environment Protection Authority (CEPA), the Institute for Applied Ecology (IAE University of Canberra), Community



Development Initiative (CDI), Oil Search Limited – PNG, Esso Highlands Limited (EHL) and the local landowners of Kikori.

This management plan describes the actions considered necessary to sustainably manage the species in the Kikori River Basin. The plan details the taxonomy, ecology and distribution of the Pig-nosed Turtle, and outlines the major threats and management actions needed to prevent its further decline based on the issues and impacts identified in Pig-nosed Turtle assessment reports and research.

The plan is based on a clear understanding of the region, its resources and values associated with it by the local inhabitants. It is envisaged that this management plan will be incorporated with the development plans of the Kikori Local Level Government, the Gulf Provincial Government and the Conservation and Environment Protection Authority in relation to future development in the Kikori River Basin.

LESSON 29A – Junior Primary

Name of Lesson: Saving the Special Species of Kikori River Basin - Factsheet

Objective: By the end of this lesson, students can:

- Recognise the importance of endangered and endemic species of Kikori River Basin.
- Produce factsheets to provide information on the endangered and endemic species of Kikori River Basin.

Key Knowledge:

1. Importance of the endangered and endemic species.
2. Information on the endangered and endemic species.

Materials Needed: Note books, pens, pencils, coloured markers, pencils or crayons, used cardboards, poster or butcher papers, activity sheets.

Preparation: Ensure groups are divided into groups. Also see Appendix B on page 198-199.

Activity: Factsheet – Start the lesson by reading the short descriptive story about selected endangered and endemic species of the Kikori River Basin e.g. the Pignose Turtle, Doria's Tree Kangaroo and Kutubu Rainbow fish (see Activity sheet 6.2). Then ask follow up questions i.e. ask students to name three important facts about each species. For example, what it looks like, what it eats, or other special characteristics it has.

Tell the students that they will produce a factsheet about one of the flagship species of Kikori River Basin e.g. Pignose Turtle or Doria's Tree Kangaroo. Divide the tasks so that each student can contribute to this. That is:

- One student can draw the picture of the endangered and endemic species chosen by their group. This should emphasise the important facts highlighted in the discussion.
- Two students with good handwriting can design the title and the wordings.
- Other students can collect additional information and give it to the group leader.
- Everyone can take turns in decorating their factsheet.

Have the students put up their factsheets on different noticeboards around the school. This will enable more students to read the factsheets. Copies can also be made and distributed to the wider community.

Evaluation/Homework: Remind the class about the importance of the endangered and endemic species of Kikori River Basin. For homework, students can complete their factsheets before the next lesson.

Assessment Activity: This is an assessable activity. You can assess your students' work by writing a set of criteria that will help you to fairly mark the activities. The group leader must give you an honest assessment (peer assessment) of each of his or her group members.

Activity Sheet 6.2– Special Species of Kikori River Basin

Descriptions of some endangered and endemic species of Kikori River Basin.

A. The Pignose Turtle

The Pignose Turtle lives in Southern New Guinea in the Fly and Kikori rivers. It also lives in Northern Australia. The Pignose Turtle got its name because its nose is like a pig's nose. It also has feet called flippers like sea turtles.

The Pignose Turtle eats different kinds of plants and animals. For example, it eats fruits and leaves of fig as well as small water animals and insects.

The Pignose Turtle lives for up to 18 years before it lays eggs. At the end of the dry season, it lays its eggs in the sandy beaches.



B. Doria's Tree Kangaroo

This tree kangaroo is found in the mountains of Mt. Bosavi. It is one of the largest tree-kangaroo species. On average, it weighs between 6.5–14.5 kg. It is about 51–78 cm in length and has a tail of about 44–66 cm long. It has long dense brown fur with black ears and a pale brown or cream tail.

The Doria's Tree Kangaroo has large and powerful claws and a stocky body that gives it a bear-like appearance.



C. Kutubu Rainbow Fish

The Lake Kutubu Rainbow fish can reach a length of at least 12 cm. The colour of its body varies from brilliant turquoise blue to more greenish shades on the upper half of the body, while the lower half is white. The back can sometimes have a golden shine.

This fish is endemic to Lake Kutubu. It is known by tropical fish keeping enthusiasts as the Turquoise Rainbow or Blue Rainbowfish, and is only found in Lake Kutubu and its outlet in the Southern highlands in Papua New Guinea.



LESSON 29B – Junior Primary

Name of Lesson: Saving my Forest and Freshwater Ecosystems – Poster.

Objective: By the end of this lesson, students can:

- Recognise the threats on the endangered and endemic species of Kikori River Basin.
- Suggest ways to protect the habitats of the endangered and endemic species of Kikori River Basin.

Key Knowledge:

1. Threats on the endangered and endemic species of Kikori River Basin
2. Saving the forest and freshwater ecosystems of Kikori River Basin.
3. Awareness on the protection of endangered and endemic species of Kikori River Basin

Materials Needed: Note books, pens, pencils, coloured markers, pencils or crayons, used cardboards, poster or butcher papers.

Preparation: This activity may take up to two lessons to teach. Students will work in groups of five or six. These posters will be used for awareness in the school and their communities.

Activity: Making a Poster - Have a class discussion by asking students to name the different plants and animals found in the forest and freshwater ecosystems of Kikori River Basin. Write up the responses on the board. You may need to assist students in naming the organisms in English. Have a further discussion about what happens to these organisms if they continue to over harvest them. Explain that continuous use of resources can harm them and threaten their lives. Even the ecosystems will be destroyed if over used.

Divide the class into manageable groups of five to six students. Tell the students to use a few words only on their posters but ensure that they draw a few pictures of the animals, for example: SAVE OUR FOREST or PROTECT OUR RIVER, etc. Distribute materials for making posters to each group. Make sure a group leader is appointed to take charge and make final decisions on what his or her group is to do.

Once the students have completed their work, they can present them by:

- Setting or pinning up their posters or charts in common places around the school area.
- Giving speeches about the protection of coral reefs during lunch hour for teachers and students.

Evaluation/Homework: Remind the students that the endangered and endemic species of Kikori River Basin must be protected for the future. For homework, students can talk to their family about the importance of these species in the Kikori River Basin.

Assessment Activity: This is an assessable activity. You can assess your students' work by writing a set of criteria that will help you to fairly mark the activities. The group leader must give you an honest assessment (peer assessment) of each of his or her group members.

LESSON 30A – Senior Primary

Name of Lesson: Saving my Freshwater Ecosystem – Debate!

Objective: By the end of this lesson, students can:

- Recognise the threats on the endangered and endemic species of Kikori River Basin.
- Suggest ways to protect the endangered and endemic species of Kikori River Basin.
- Stage a debate to argue for or against these.

Key Knowledge:

1. Importance of terrestrial and aquatic life and ecosystems.
2. Conservation of terrestrial and aquatic organisms and places is vital.

Materials Needed: Note books, pens, pencils, and poster or butcher papers. As well as timer or clock, chairs, tables, a bell, and score sheets

Preparation: This activity will take up a double lesson.

Activity: The Debate - Students will work in two groups to debate for and against the importance of protecting forest and freshwater ecosystems. The debate will be staged for the whole school to observe. The topic is: *“Protection of Terrestrial and Aquatic Ecosystems are more important than Economic Development”*.

To do this, divide the class into two groups. Group 1 should argue that this statement is true. They should also provide three (3) or four (4) supporting points for their argument. Group 2 should argue that this statement is not true. They should also provide three (3) or four (4) supporting statements for their argument.

Each group should discuss what they have learnt in the previous topics and lessons in this resource book. These should provide the basis for their arguments. Each group should also select three main speakers to represent their team.

You should arrange with the head teacher and the school administration on when to stage this debate. (This can be done during outdoor assembly, lunch break, World Environment Day or after classes). Students from the class can help with arranging the room for the debate and becoming the time keeper. You can be the chairperson of the debate and arrange with other teachers to act as judges.

Evaluation/Homework: Remind the students that the endangered and endemic species of Kikori River Basin and their ecosystems must be protected. For homework, students can prepare their questions on the work of IUCN and WWF.

Assessment Activity: This is an assessable activity. You can assess your students’ work by writing a set of criteria to help you to fairly mark the group’s performance and participation in the debate. Group leaders can assist with providing peer assessment of their group members.

LESSON 30B – Senior Primary

Name of Lesson: Saving my Freshwater Ecosystem – General Awareness.

Objective: By the end of this lesson, students can:

- Take action to protect their forest and freshwater ecosystems.
- Recognise the importance of the work of IUCN and WWF.

Key Knowledge:

1. Commitment of Papua New Guinea to biodiversity conservation.
2. IUCN and the work of WWF to conserve nature.

Materials Needed: Note books, pens, pencils, coloured markers, pencils or crayons, used cardboards, poster or butcher papers.


Preparation: This activity will need two lessons to complete. Students will work in smaller groups of four to five members. Prepare completed work produced by each group for displays.

Activity: Awareness – Have the class reflect on the topic of conservation and management of the Kikori River Basin. Have a brief discussion on the importance of endangered and endemic species of this region. Inform the class that it is important to spread the message to create more awareness on the importance of the forest and freshwater ecosystems and the species that live these places.

To begin these awareness activities, give an awareness talk on the work of IUCN and WWF in the conservation of nature. You can use the background notes and information in this resource book to prepare this awareness talk. If you are able to invite a WWF officer or their community representatives, you can do so to make the talk more exciting. Allow time for students to ask the questions they have prepared. You can also prepare some questions and give to different students to ask.

The next step is to involve the students. To do this, have the class divided into their work groups. Each group is to choose one of the following activities to do:

- 1) Write big book stories about terrestrial and aquatic life. Then read these stories to younger students in the lower primary and elementary grades.
- 2) Compose songs and poems about plants and animals in the forest and freshwater ecosystems or about pollution or about the over fishing and harvesting of terrestrial and aquatic resources. This can be performed as a competition in the school. *Arrange with teachers for students to carry out their performances during school assembly, or the lunch break and invite parents to observe this activity.*
- 3) Plan a public speech with posters or charts showing pictures of endangered and endemic species of the Kikori River Basin. *Make necessary arrangements with the school principal or head teacher about the speeches. This can be done during school assembly or the lunch break.*

- 
- 4) Design brochures, e.g. about the importance of protecting terrestrial or aquatic life and its habitats. They can hand these brochures to teachers and students in the school, to people in the community, and the public.

Ensure all the activities are planned and prepared by the students.

In the next lesson, set up at the assembly ground to display the students work. Use the lunch hour to have students; teachers and parents visit each display. Each group should talk to the visitors to their displays to create awareness on the endangered and endemic species of the Kikori River Basin.

Evaluation/Homework: Ensure that students have completed their displays and return the furniture and other materials used. Commend the class for their efforts and finish off with a small quiz on the topics.

Assessment Activity: This is an assessable activity. You can assess your students' work by writing a set of criteria that will help you to fairly mark the activities. The group leader must give you an honest assessment (peer assessment) of each of his or her group members.

6. GLOSSARY

Absorb	Soaking or drawing up substances like liquids, gas, heat, light or forms of energy.
Adaptation	A change in an organism that makes it better suited to a particular environment.
Aquarium	A glass container of water in which a variety of plants and animals are kept.
Atmosphere	A layer of gas or air around the Earth. The kind of air that you breathe around you which could be fresh or polluted, especially in industrialised areas.
Biodiversity	The variety of life on earth. It includes everything from the smallest to the biggest or tallest living thing.
Camouflage	The way in which animals and plants use their colour and shape to blend in with their natural surroundings.
Carnivore	An animal that eats meat or flesh.
Chlorophyll	Green coloring matter found in the leaves of green plants that enable them to make their own food.
Conservation	Preserving, protecting, improving and managing natural resources such as farmland, rainforest and water in such a way so that they are kept in good condition for the present and future generations.
Conservationist	Someone who cares greatly about the conservation of the environment and who works and campaigns actively to try to protect it.
Conserve	If you conserve a supply of something, you are very careful in the way that you use it so that it lasts as long as possible.
Detritus	Organic matter formed by the decomposition of plants or animals.
Ecology	Branch of science that deals with the study of the relationships between living things and their surrounding environment.
Element	Part or thing in the environment, living or non-living.
Endangered	A species that is being threatened or in danger of being destroyed or damaged.
Endemic	A species of plant or animal that is naturally found only in a particular place and nowhere else.

Environmentalist	A person who is concerned about the natural environment and wants to improve or protect it.
Epidemic	A sudden increase in the rate or occurrence of a disease to a state above normal, affecting large numbers of plants and animals.
Erosion	Wearing away of the soil's surface by running water, wind or ice; separation and movement of soil or rock particles by water, wind or ice.
Exotic	Something unusual and striking; something foreign and unusual, especially a plant or animal.
Extinction	A species of living thing that disappears altogether from the earth.
Food chain	Series of living things with related eating habits. In a food chain one organism is eaten by another which is then eaten by another.
Food web	A more complicated relationship of eating habits but similar to the food chain. It is made up of more than one food chain.
Greenhouse effect	Trapping of heat from the Sun by the effect of the earth's atmosphere as a result of atmospheric pollution. This raises the temperature above normal in certain areas of the world.
Habitat	Where an organism lives such as a pond, the seashore, the canopy of the rainforest.
Herbivore	An animal that eats plants.
Introduced	A plant or animal species that is brought in from somewhere else (usually another country). Some of these can cause problems for native species in terms of competing for food and shelter.
Marine life	All living things in the sea/fresh water.
Microcosm	Something that is seen as a small version of something large.
Nutrients	Substances that are absorbed into plants or bodies of animals and humans to help them grow.
Natural Resources	A feature or component of the natural environment that is of value in serving human needs, e.g. Soil, water, wildlife, etc. Some natural resources have an economic value (e.g. Timber) while others have a 'non-economic' value (e.g. Scenic beauty).
Organism	Living plant or animal of any size.
Photosynthesis	The process in which green plants make their own food using carbon dioxide and water and the presence of sunlight.

Pollution	Changes in the air, soil or water that spoils the environment and makes it less useful or dangerous to plants, animals and human beings.
Recycle	A process by which a used resource is recovered and used again.
Renewable	Something that is capable of replacing itself after it has been used, destroyed or lost.
Re-use	To use something again.
Species	A class of plants or animals or a variety of the same class, whose members have the same main characteristics and are able to breed with each other.
Sustainable	If you sustain something, you maintain it or keep it going for a period of time.
Sustainability	Able to be used without being completely used up or destroyed.
Symbiosis	A type of relationship where two organisms permanently live with each other which can benefit or harm one of them.
Terrestrial	This refers to the life on earth, which includes plant and animal life.
Waste product	A useless material or substance produced while making something else.
Water cycle	The movement of water between the atmosphere, the land and sea water.
Weathering	The slow breaking down of the surface of rocks into small particles caused by wind, chemical reactions, changes in temperature and waves.
Wetland	An area that has a lot of water and is normally wet.

7. ACRONYMS

asl	Above sea level
ha	Hectare
m	Meter
masl	Meter above sea level
PNG	Papua New Guinea
WMA	Wildlife Management Area
WWF	World Wide Fund for Nature
CEPA	Conservation and Environment Protection Authority

8. RESOURCES

Tokiwa Publications – Shell Books, Big Books, Environment Posters, Book of Stories, Poem Books, Recipe Book, Factual Information Readers – 2019

NDOE, Junior Primary Science Teacher Guide – 2018

NDOE, Junior Primary Social Science Teacher Guide - 2018

NDOE, Senior Primary Science Teacher Guide – 2018

NDOE, Senior Primary Social Science Teacher Guide - 2018

9. REFERENCES

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Norris, B. & Genorupa,V. (2012). World Heritage in PNG, World Heritage News Letter, Papua New Guinea World Heritage Secretariat, Volume 1, Issue 1Monday 12th March 2012.

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9. APPENDICES

Appendix A - Major Threats in the Kikori River Basin

National Infrastructure Development



Building roads, bridges, wharves and towns require land clearing, moving and flattening the soil, building storm water drains and a lot of physical construction. Such development work changes the natural environment for better or for worse. The Kikori River Basin is a pristine primary forest area. Communities are scattered through-out the basin. However, Government access roads will be built, and will bring changes to the Basin's uniqueness.

Deforestation

Logging in PNG has been going on for many years. Logged timber has been exported to overseas countries. Logging was used by the government to remove large tracts of forest to convert the land for coconut, cocoa and oil palm development. Today logging continues in support of oil palm development and is the reason for complete removal of primary forests in PNG. Kikori River Basin faces the similar removal of forests for oil palm development as in other parts of the country.

In Kikori River Basin, there are nine Forest Management Agreement (FMA) Concessions covering 1.1million ha (approx. 50%) of 2.3 million ha proposed World Heritage Site area²⁷. It spans across extensive land area from the mouth of Kikori River and the Delta area to the inland of Mt Bosavi and Nipa-Kutubu regions. Where five²⁸ FMAs are active logging operation sites and the remaining four are proposed concession areas²⁹.

²⁷ WWF PNG Report (2017)

²⁸ Turama, Turama Block 1, Kikori Block 2, Baimuru block 3, and East Kikori

²⁹ Bosavi, Hekiko, Kutubu-Poroma, and Nogoli

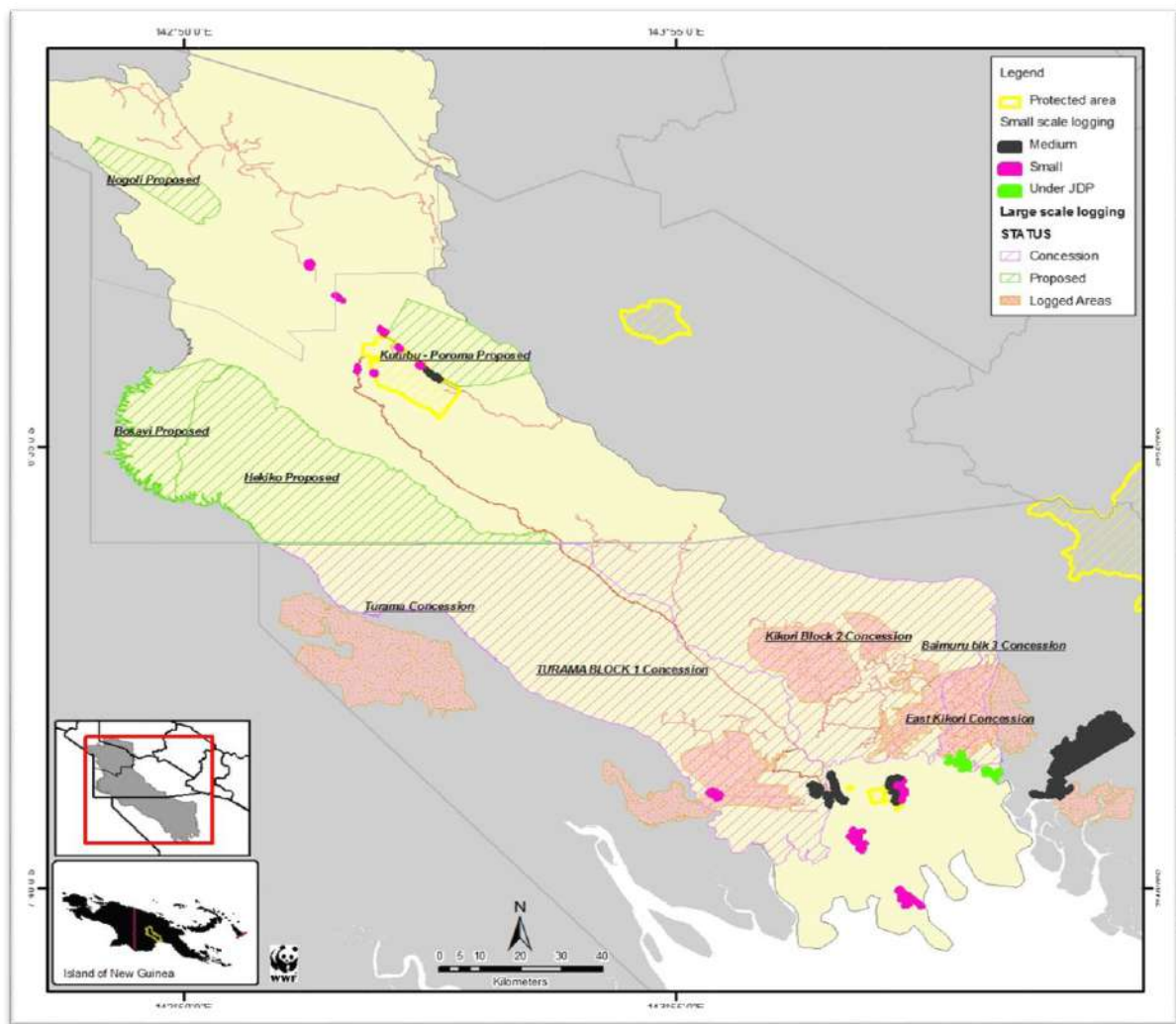


Fig.40 Forestry concession map for large and small scale commercial logging in KRB.

The logging activities by portable sawmill operators mainly supply rough sawn timber to Oil & Gas Project infrastructure developments and accounts for 60,000ha (600 km²) under active management. About 90% of such operations are illegal & unsustainable. WWF report (2017) found that 47 sawmill groups existed in Kikori region (Gulf Province) than in Kutubu region (Hela & SHP). The land use change from such activities account for 2.7 % deforestation rate between 2010-2015 periods. While WWF attempts to support the portable sawmill operators with Eco-forestry alternative, the trend remains. The PNG Forest Authority forest governance and monitoring compliance enforcement is also weak. This has further provided the opportunity for growth of unregulated forest land use practices.

Exotic Species (Invasive Species)

Any plant or animal that is brought into a country, and is not a native species of the receiving country is called an *exotic species*. It is also referred to as *invasive species*. In PNG, many freshwater fish such as tilapia, carp and gourami are fish originating from other countries such as Africa and Asia. These were brought in by the colonial administration into PNG. Exotic plants include the common large rain trees from Africa that are seen in and around the capital, Port

Moresby. In addition to land based exotics, in aquatic ecosystems; freshwater, estuarine and marine; large international vessels sailing into other maritime nations, may bring exotic marine species. Marine exotics either are species growing on the underside of boats such as barnacles or from ballast waters, ships pump in and out during travel and transit in and out of international ports.

Whilst exotic species may be beautiful, the problem arises when these species take over or colonise habitats of native species. If this happens, and the exotic species numbers increase and cause native species to die off, it affects the natural biodiversity.

The Kikori River Basin is already faced with changes to the fish fauna. A tilapia species brought in for aquaculture escaped and entered the Lake Kutubu and other river systems in the area. They have spread so fast because the tilapia is a very aggressive in reproducing fish and has colonised the entire freshwater habitats within a short time period.

Illegal & Unsustainable Fishing/Harvesting Practices



Fig. 41 Fishing in Lake Kutubu

Illegal fishing refers to fishing without an authorised Fishing License. Unsustainable fishing or harvesting practices refer to fishing undersized or immature fish or shellfish. Overharvesting refers to fishers collecting or fishing out entire fish stocks in a single harvest period.

In PNG, illegal fishing is where the PNG National Fisheries Authority has not issued a fishing license to catch fish commercially. This refers to commercial fishing for tuna, prawns, lobster and beche-de-mer fisheries. In the case of tuna fishing, either a foreign vessel enters PNG's fishing zone without a fishing license and starts fishing or locally based vessel based out of PNG are fishing commercial fish species without a license, this also constitute illegal fishing.

Papua New Guinea has a sea border called the Exclusive Economic Zone which is 200 nautical miles from the baseline shoreline of the country. This boundary holds 2.3 million square kilometers of ocean space which belongs to PNG. This contains valuable marine resources such as tuna, sharks, whales, dolphins, coral reefs, reef fish, islands and coastal mangroves.



Fig. 42 Native fish species of Lake Kutubu (Fimbrig gudion)

Overfishing in our local streams, lakes and creeks can result in the depletion of fish stock. This happens when there is increase in human population, land use change, pressure on food security and people tend to do more fishing than other livelihood activities. Or, people's preference for a particular fish species for a delicious meal, then the high demand may result in wiping out that fish stock in the wild. For example, we have 12 endemic local fish species in Lake Kutubu. If fishing pressure increases because of local situation, it is likely that the native fish population may decline and eventually become extinct. Other factors that may affect the fish stock are environmental impacts from local land use and industrial oil or gas infrastructure development projects.

Proposed KRB Boundary Conflicts with Oil and Gas Tenement Area

The KRB is in the Oil and Gas tenement area. The Oil and Gas Industry was there before the KRB was listed as World Heritage Tentative List site. The Oil and Gas Act 1998 requires oil and gas developers to operate under a number of licenses listed under section 187, 188 and 189 of the Oil and Gas Act. These licenses include; Petroleum Prospecting license (PPL), Petroleum retention license (PRL), Petroleum Development license (PDL), Pipeline License (PL) and Petroleum Process facilitating License (PPFL). Currently, there is an Application of Petroleum Development License (APDL) over the P'nyang field in Western Province.

A dedicated facility includes the pipeline as well as the petroleum processing facility; or any other facility used exclusively by the tenement holder or other persons in carrying on that petroleum project.

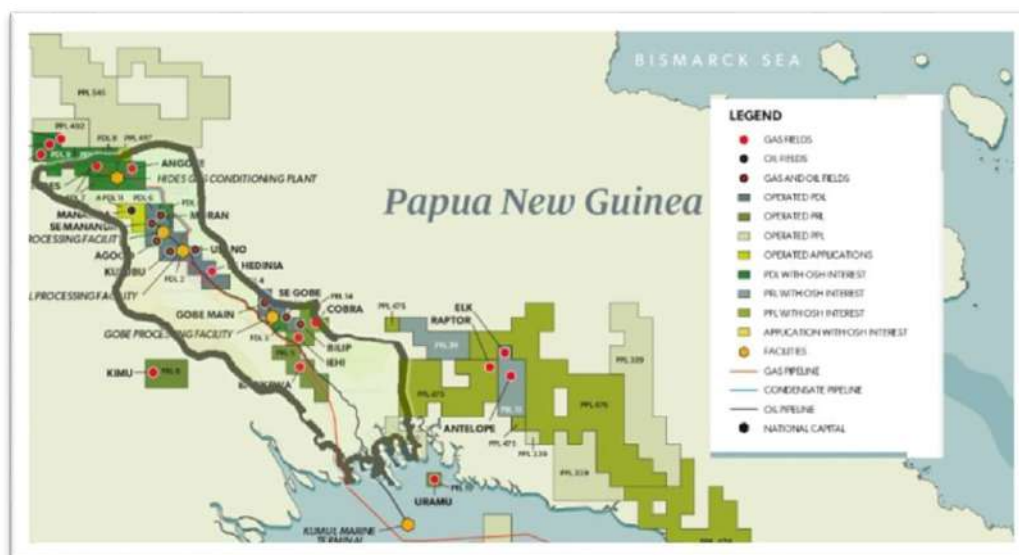


Fig. 43 Putting the KRB in perspective of the oil and gas project

For WWF to nominate a site in the oil and gas licence area, they can be prosecuted for trespassing under oil and gas legislation. The Oil and Gas Act 1998 under Section 122 prohibits people other than the license holder to enter or occupy any land in the license area connected to the oil and gas operations. This also applies to petroleum processing facility as well as the pipeline or even any land that is kept vacant for the purpose of compliance to petroleum law. For all the license areas, there is a 5 km buffer zone around the dedicated project facilities. Furthermore, in 2008 the IUCN issued a statement calling for WH sites to be off limits to extractive industries, including oil and gas³⁰.

Mineral & Gas Prospects Development³¹

Mineral Sand Bed Mining

Mayur Resources is advancing the exploration and prospecting of the miner sand bed mining in the Gulf Province, especially on the delta region of the Gulf of Papua. The Myur Resources which holds the tenement license is currently prospecting the Orokolo Bay Industrial Sand Projects where part of it covers the Kikori River Delta Region.

³⁰ <https://www.iucn.org/theme/world-heritage/resources/iucn-policies-world-heritage/mining-oil-and-gas>

³¹ <http://mra.gov.pg/Search-Results?Search=PEAT>



Fig. 44 Mayur's industrial minerals Exploration Licences and location of the Orokolo Bay Project

Mining

Mayur Resources holds a portfolio of tenements that cover the main coal bearing geology in the Papuan Basin in southern PNG. Although there has been a long history of coal prospecting in the Gulf Province, coal mining has never been developed in PNG, unlike its neighbours in Indonesia and Australia.

The Gulf region includes the outcropping 'Shu Coal Measures' (within the coal-bearing Era Beds formation) and is generally low lying and home to some of PNG's major river systems including the Purari, Vailala and Kikori, that offer potential options for transport and access. The most advanced deposit in the portfolio is at Depot Creek located approximately 20km from the Purari River.

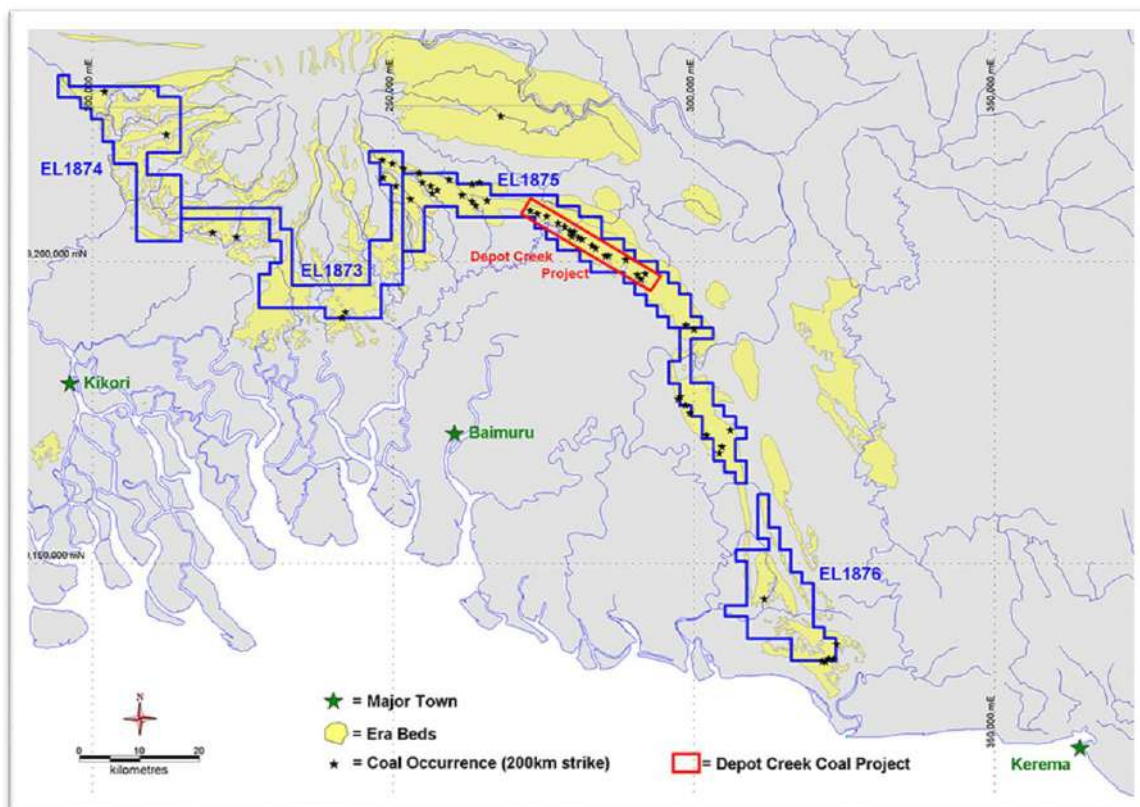


Fig. 45 Map of Mayur's coal exploration licenses (Gulf Province)

Papuan LNG

Kikori District is one of the 89 districts in PNG. It hosts 80 per cent (18 trillion cubic feet) of the discovered but undeveloped gas reserves in PNG. The planned Ihu Special Economic Zone (ISEZ) is ideally located for future development of PNG's gas industries, including LNG, LPG, power generation and petrochemicals. It currently hosts the Kutubu Oil export pipeline and offshore Kumul marine terminal. Kikori will also be the base for the central processing facility for the country's second LNG project, Papua LNG, and the planned offshore Twinza Oil's Pasca Gas Condensate Project, the first of its type in the country.

A development application for the field has been submitted, with first production targeted for 2020. The field contains 19 million bbl of condensate and 20 million bbl of LPG. The propane component of the LPG will be sold into Papua New Guinea's domestic market while the condensate, butane, and excess propane will be exported. The liquids project is expected to have a 20-year lifespan with a development cost of US\$350-550 million.



Fig. 46 Total Papuan LNG Project

Government Infrastructure Developments

*Trans Papuan Highway*³²

This is the highway linking Asia through PNG & Indonesia through China's One Road Belt Initiative. The Trans-Papua Highway (Indonesian: Jalan Raya Trans-Papua) refers to 12 road segments, some under construction, across Papua and West Papua provinces of Indonesia, located in the island of New Guinea. The roads stretch from Sorong to Merauke with a total length of 4,325 kilometers. Constructions on all the roads are predicted to finish in 2018, with 3,850 kilometers of roads being completed in March 2017. The completed road segments include 884 out of Indonesia's 1,068 kilometer border road with Papua New Guinea. The remaining parts of the road, including 7,000 meters of bridges, are planned to be completed in 2017 and 2018, although not the entire road has been layered by asphalt.

³² https://en.wikipedia.org/wiki/Trans-Papua_Highway

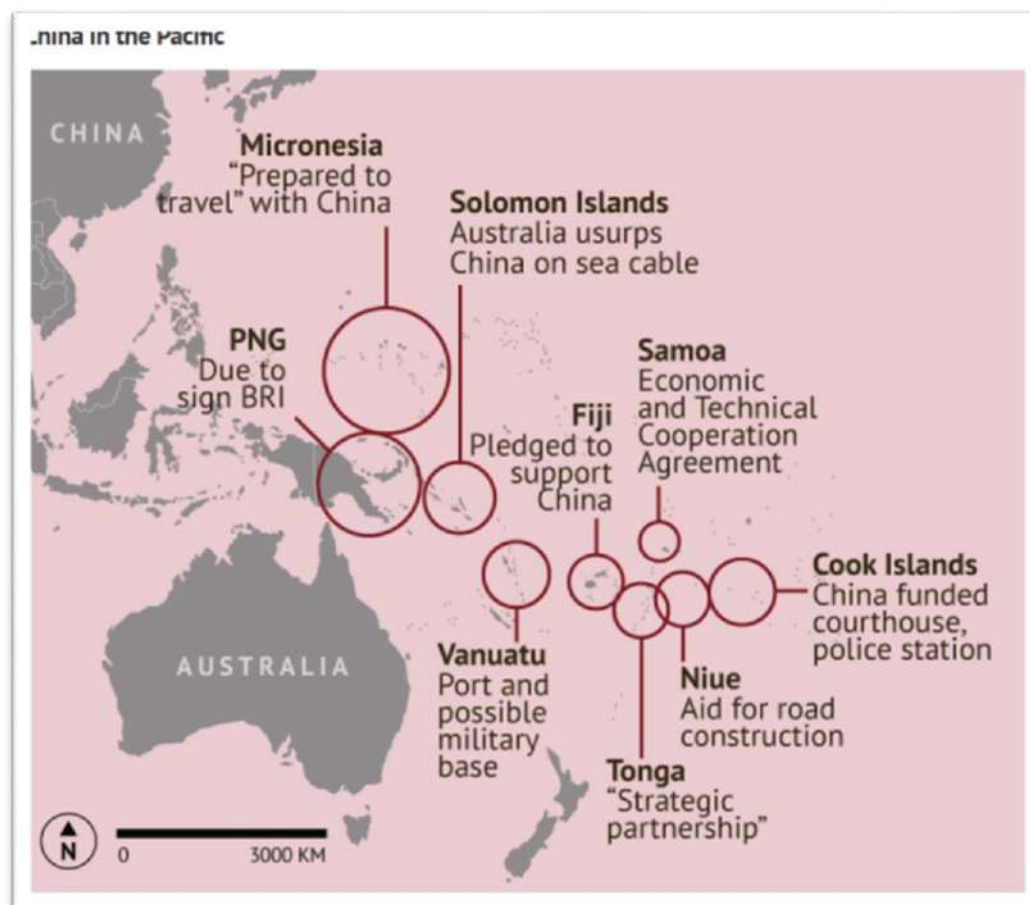


Fig. 47 PNG including other Pacific Island countries sign to China's BRI³³

PNG signed up to China's Road & Belt Initiative in 2018 and committed each country to working with China on infrastructure projects badged under the \$US1 trillion (\$1.3 trillion) program. As part of this agreement, plans are underway to double its national road network (from 8,700 to 15,000 km) over the next three years, to spur economic growth. In Kikori River Basin, key infrastructure development, especially road network has been planned to open up "Economic Corridors" thus capitalizing on Oil & Gas Projects & Logging to drive this policy.

Special Economic Zones (Kikori Township Expansion)³⁴³⁵

Great plans are ahead to convert the Kikori Delta Region in Papua New Guinea into a free economic zone. A fifteen-year plan to develop the Ihu Special Economic Zone is expected to be approved in 2020. Driving its development will be the infrastructure requirements for PNG's second LNG Project – Papua LNG.

³³ <https://www.smh.com.au/world/asia/looking-north-png-signs-on-to-china-s-belt-and-road-initiative-20180621-p4zmyv.html>

³⁴ <https://news.pngfacts.com/2018/01/kikori-delta-in-png-set-for-development.html>

³⁵ <https://www.businessadvantagepng.com/papua-lng-expected-to-drive-development-of-special-economic-zone-in-gulf-province/>



Fig. 49 Ihu Special Economic Zone (ISEZ). Credit: Office of Member for Kikori Open Electorate

Centered on the Kikori District of Gulf Province, Ihu Special Economic Zone (ISEZ) will consist of free trade zones, construction of a 100-room hotel and accommodation, schools, and health facilities. Other landscape management projects include Petroleum Park, industrial zone, Technology Park, Forestry Park, a deep-sea port, a township with government and administration area.

Appendix B - Iconic Species of Kikori River Basin

1. BOP (*Paradisaea raggiana*)

Birds of Paradise prefer to live in tropical rainforests. They feed primarily on berries and wild fruits located in their habitat. Data recorded by WWF from past biodiversity surveys indicated that of the 31-different BOP species found in PNG, 24 are confirmed to inhabit in the Kikori River Basin and 6 are residents of the Kutubu region.

2. Giant Woolly Rat

Discovered in Mt. Bosavi, Southern Highlands Province in 2009 and is known as Bosavi Woolly Rat. It is believed to belong to the genus *Mallomys* although this has yet to be published. The silvery grey mammal has dense fur and its teeth suggest it has a largely vegetarian diet and probably builds nests in tree hollows or underground. This is one of the world's largest rats.

3. Pig nosed Turtle (*Carettochelys insculpta*)

Also known as the Pitted-Shelled Turtle or Fly River Turtle is a species of turtle native to northern Australia and southern New Guinea. This is commonly found in the Kikori Delta and along Kikori River.

4. Long beak Echidna (*Zaglossus spp*)

Echidnas are one of the two types of mammals that lay eggs, the other being the platypus. The echidnas retain reptilian features such as egg-laying but display mammalian features such as fur and lactation. It is found in both Kikori and Kutubu region

5. Orchid

There were large numbers of new orchid species found in Kikori Kutubu region. Eight species have been documented by WWF as new species. Many of these plants, including those which may contain cures to some of the world's most deadly diseases, may become extinct before they have been discovered. This gives even greater urgency to ensuring the long-term conservation in the region.

6. Silky Cuscus(*Phalanger sericeus*)

This animal, which resembles a small bear, is a marsupial that lives up in trees, feeding on fruits and leaves. It is found in Mt. Bosavi and along the central part of New Guinea. Weighs about 5-10 kg and has thick silky fur adapted for the mountain environment in which it lives.

7. Digaso (*Campnosperma brevipetiolata*)

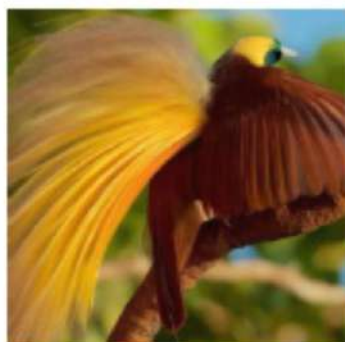
A tree species traditionally used to extract traditional oil. It is found growing among sago palms in the swampy areas across Kikori River Basin. The oil is rubbed to give shiny black look during ceremonial dance.

8. Tree Kangaroo (*Dendrolagus dorianus*)

Found in the mountains of Mt. Bosavi. One of the largest tree-kangaroo species, and, on average, weighs between 6.5–14.5 kg. Its length is 51–78 cm, with a long 44–66 cm tail. It has long dense brown fur with black ears and a pale brown or cream no prehensile tail. It has large and powerful claws and a stocky build that gives it a bear-like appearance.

9. Kutubu Rainbow Fish (*Melanotaenia lacustris*)

The Lake Kutubu Rainbowfish can reach a length of at least 12 cm. The body colourations varies from brilliant turquoise blue to more greenish shades on the upper half of the body, while the lower half is white. The back can sometimes have a golden shine. This fish is endemic to Lake Kutubu. It is known by tropical fish keeping enthusiasts as the Turquoise Rainbow or Blue Rainbowfish, and is only found in Lake Kutubu and its outlet in the Southern Highlands.



1. Bird of Paradise



2. Orchid



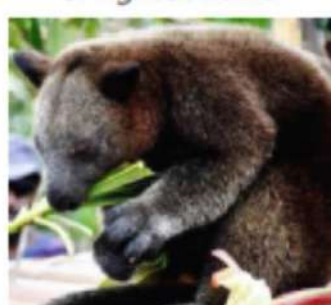
3. Pignose Turtle



4. Kutubu Rainbow Fish



5. Inshore Dolphin



6. Doria's Tree Kangaroo



7. Silky Cuscus



8. Long-beaked echidna



9. Giant Woolly Rat



Appendix C - Field Trips or Excursions

There may be many reasons why you are reluctant to take your classes outdoors. One is the feeling that you lack the scientific knowledge. Another is a question of whether or not you will lose control of the students outdoors and the third could be for cultural or social reasons.

To answer the first concern, you should accept that you don't need to be a science-trained teacher to take your class on a field trip. It is being honest to say 'I don't know' to some questions and advise the students that they will learn about this later, or challenge them to research the topic. Another way is to get into it yourself, and by experiencing it, you will slowly become confident in conducting outdoor activities.

Every field trip must be organised and you need to be clear about both the learning aspects and how to manage the students outside the classroom. You have to decide on an activity appropriate for the age and learning level of your students.

Here are some tips to encourage you to consider when planning a field trip (they are in no particular order):

- Is the field trip in the school yard or nearby?
- Do the students know from the start, the purpose of the field trip?
- Do they know the types of dangers they are likely to face and how to avoid them?
- What first aid equipment is required for this field trip?
- Does the field trip involve walking on roads which vehicles use?
- Is transportation needed?
- Is funding needed for the field trip?
- Is safety clothing required, for example closed-in shoes?
- How will the students carry lunch, water, equipment, and note-taking materials?
- What will the students need in the way of protection, for example, umbrellas or hats for shade?
- Will parents or community members be asked to help?
- What effective teaching and learning strategies will be used, for example, observation sheets or questionnaires?
- Will the students work in groups, pairs or as individuals?
- What methods of control you use? For example, blow the whistle twice for danger and once for coming together for discussion.

You may have carried out an excursion with your students before. In this case, you would have compiled notes, questionnaires which can be adapted for other classes.

Appendix D – Stories and Poems

The stories and poems in this section will help you to teach concepts about the environment that may be difficult for your students to understand. These stories and poems should be an enjoyable reading experience for you and your students. The stories are:

1. Piku the Pignose Turtle is Worried
2. Kasper the Happy Little Tree Kangaroo
3. Eric Finds a New Home
4. The Beautiful Butterfly

Poems

Poems help you and your class to express your thoughts and opinions about something so important as animals and plants. The following are poems written by some teachers who were concerned about overharvesting and exploitation of natural resources.

<i>Plants, animals and people</i>	<i>Trees</i>	<i>Marine Life</i>
<i>Plants, animals and people Needing the same thing Fresh air, clean water, Food and shelter.</i>	<i>Count the trees for life One, two, three No more big trees left Any small trees Count the trees for life One, two, three Take care of small trees Save three trees for life</i>	<i>Sea urchins and sea shells and sea cucumbers suffering at the seashore.</i>
<i>Plants don't need shelter They do need Sunlight To grow</i>		
<i>Plants, animals and people Part of the environment So we must use it with Care.</i>		
By Savie Bangbang	By Janet Sapak	By Eshwin Penias

Piku the Pignose Turtle is Worried

A short story by Jennifer Sangga

It was very quiet in the classroom. The early morning Sun was warming the building and soon it will be too warm to stay indoors. The children were busy writing. They were using their new exercise books. Mr Gecko, their teacher was also busy writing on the chalkboard. All the children were very busy working except for Piku the Pignose Turtle. Pukpuk who shared the desk with her was also very busy writing her notes into her new exercise book. She was so pleased with her new book that she wrote her notes down carefully making sure not to make a lot of mistakes as this might make her book messy.

Piku sat with both of her hands on her chin thinking about what had happened the day before in the lagoon. She had sat on the beach with Pukpuk her best friend and watched as the men from her village poured onto the beach all the fish that they had caught in the fishing net. It had really bothered her so much last night because she had seen so many tiny fish. Why had these men caught the small fish too? They are too small and are not ready to be eaten. They had watched the village men use poisonous roots from a certain plant found in the bush to kill all these fish in the lagoon. The men had actually thrown away the smaller fish into the sea. The small fish were all dead and floating on the tiny waves splashing on the beach as they got carried out to the lagoon and the deep sea.


Piku then realised that she should have been writing down her notes into her new exercise book. After writing a couple of lines she turned to Pukpuk and whispered that she had something very important to tell her.

"It's about the fish we saw yesterday at the beach," whispered Piku. "A lot of the fish were too small to be eaten so the men threw them away," continued Piku.

"Well my friend, I heard some time ago on the radio that we must take good care of things around us and not use them carelessly," whispered back Pukpuk. "This person was talking about our environment and that it is important. He said if we are not careful then we may run out of food and other things that are important for our lives," whispered Pukpuk.

"Does this mean that the village men should have caught the fish using another way so that only the big fish are caught?" asked Piku in a low voice.

"Yes, Piku, the poisonous plant killed other living things in the lagoon as well as all the fish we saw at the beach yesterday," replied Pukpuk in a low voice too. "If the village men keep on killing the fish using the poisonous root then all the other sea animals will be killed too. You and I including everyone in the village will not have any more food to get from the sea," continued Pukpuk in a worried voice.



Piku was so upset to hear this news and became worried for she loved to eat seafood. What can she do to help stop this practice?

"Keep quiet Piku and Pukpuk and make sure you complete your work by this afternoon or you'll be punished before you go home", shouted Mr Gecko. "Anyway, were you both discussing something interesting because I could hear you whispering?" asked Mr Gecko. "Come on, Pukpuk, please stand up and explain," added Mr Gecko.

Poor Pukpuk! She had to stand up and with a shaky voice and explained the discussion she had with Piku. The whole class had to stop writing and listened because most of them come from the same village as Piku and Pukpuk and have witnessed this going on many times before. When Pukpuk had finished explaining, Mr Gecko asked Piku to stand up too. He then asked the class to give a big clap for the girls.

He explained that they will be learning about the use of their local resources the next day and that it was good that the girls had begun this discussion. He also reminded the class that it's better to ask questions and discuss areas of concern and not to whisper amongst themselves.

Questions:

1. Has this happened in your village?
2. What would you do and what kind of advice would you give Piku the Pignose Turtle and Pukpuk?

Unpublished

Kasper the Happy Little Tree Kangaroo

A short story by Jennifer Sangga

There once lived a beautiful happy little tree kangaroo called Kasper. Kasper lived with his family on the branches of a big fig tree in the forest. Kasper was a very healthy and happy little tree kangaroo with beautiful silver-black fur. Kasper had many friends who also lived in the forest. His closest friends were Henry the hornbill, Peter the green tree python, Patrick the colourful parrot and Otto the wise old barn owl.

Kasper, his family and friends didn't have to go far to look for food as there was a lot of food to gather and eat in the forest. There are wild juicy berries, nuts of all kinds and a lot of wild fruit. There was always more than enough for everyone who lived in the forest.

Kasper, his family and friends lived happily in the forest until one lovely morning as Kasper was playing hide and seek with his friend Peter, he saw a lot of men from the village on the other side of the mountain where they live. They came into the forest carrying machines and other equipment. Kasper and Peter stopped playing and sat watching the movement of these people and the strange looking things they were carrying. The men began to cut down the nearest tree to where they were standing. Kasper and Peter knew something was not right and were upset when the men started cutting the big lovely tree down. The strange thing was making a lot of noise and many birds and animals were shocked to hear this strange noise in the forest. They smelt danger in the air as the strange thing was making a lot of noise.

Kasper and Peter moved as fast as they could to warn their family and friends about the strange moving things that have begun to destroy their home. The men had now began to burn some of the bushes near the edge of the forest. Kasper, his family and friends were frightened and ran away from their home to another part of the forest where they would be safe. They will have to build their homes again. They had to move away quickly or get caught and killed as their home and food were destroyed by these men and their strange machines.

Kasper was a very sad little tree kangaroo that day to see his lovely home destroyed. He couldn't understand why these men had destroyed his beautiful home. He had lived there all his life with his family and friends. Kasper thought if only he could understand and speak their language, he would tell them to stop destroying his home and the home of many of his friends in the forest.

Unpublished

Eric Finds a New Home

A short story by Jennifer Sangga

"Hmm ...m....," hums Eric. Eric the Eel was on his way home. "Ow! ...Ouch! My head, what was that?" "What! ...What is that?" asks Eric to himself as he looked at the object in front of him. "Oh! It's a big drum! I wonder what's in the drum".

"Eric!! Don't go near that drum," shouts Teddy. Teddy is a baby Hawksbill Turtle and Eric's best friend.

"But what is it doing here and how can I get into my home?" cried Eric feeling desperate to get inside among the coral which was his home.

"You mustn't go into your home," says Teddy.

"Why can't I do that?" asks Eric.

"Look! Look closely at the drum. See that black stuff coming out?" "It's going towards your home," says Teddy.

"Sniff..... sniff...., Teddy I can smell something," says Eric.

I can smell it too and it smells horrible," adds Teddy.

"Teddy, I think I feel dizzy," says Eric.

"Me too!" adds Teddy.

"Hang onto my tail Teddy," says Eric. "We have to get out of here fast!"

Eric and Teddy swim away quickly. The oil had covered Eric's home. Eric has to find a new home.

"I'll have to look for a new home, Teddy," sobs Eric. "I just don't know where to find another home".

"Please don't cry. You can stay here with me Eric," says Teddy feeling sorry for his friend. "There's plenty of space here and lots of food too," he adds hoping that Eric will stop sobbing.

"Thank you Teddy. You are the only friend I have," replies Eric, wiping the tears off his eyes.

Eric liked his new home with Teddy. They had lots of food to eat and a beautiful place to sleep after playing and swimming in and around the beautiful coral reef every day.

Unpublished

The Beautiful Butterfly

A short story by Jennifer Sangga

It was a lovely misty morning in the rainforest. It had rained the night before and the morning dew glistened as the rays of the early morning Sun shone on the leaves and blades of grass.

There were many beautiful flowers with colourful petals growing in the forest floor. The flowers smiled as they absorbed tiny drops of water from the mist that hung over them. The mist was gradually floating upwards into the atmosphere as the Sun's rays became warmer.

The Orchid leaned over to see if the animals living near her were awake. They were still asleep in their homes, among the forest floor and on the trees. Some smaller animals have homes among the plants underneath the trees. It was a cold morning as they lay fast asleep in their nests. A beautiful birdwing butterfly flew down and sat on her large green leaf. The Sun was nice and warm after the light rain the night before. The butterfly looked at the garden of orchids.

"Good morning," said the butterfly to the Orchid. "What a beautiful misty morning".

She flapped her wings with a sigh of satisfaction and looked at the Orchid.

"Yes," replied the Orchid. She moved her petals slightly agreeing with the butterfly. "I can only admire my environment from where I am as I can't move around," she said. It's such a wonderful morning and I don't know why the animals are still asleep. They should be up and about looking for breakfast."

"They will wake up soon as they can't go on sleeping all day," said the butterfly. "Well, well, I'd better be on my way."

She flew around the flowers. She hovered over some flowers flapping her beautiful wings.

"I must lay my eggs on the right leaf so that my caterpillars once hatched would have enough to eat," sighed the butterfly loudly. She continued to fly among the flowers and stood on a couple of leaves. She wanted to see whether the leaf was good enough for her to lay her eggs.

She finally settled on the leaf of another Orchid plant and laid her eggs. Then she flew up and landed on the flower to collect nectar. She began sipping the sweet nectar from the Orchid flower. She has a long flexible, tube-like tongue that goes down into the nectar of the flower. She sucks the nectar through her long tongue.

The Sun began to get warmer. The butterfly had sucked enough nectar. She flew back to where she had laid her eggs. She sat on another leaf and looked at her lovely little eggs. She knew there would be enough food for her baby caterpillars once they hatched. She

knows that her caterpillars eat a lot. They are munching machines. Once they hatch and crawl out they will first eat their eggshells. Then they begin eating the leaves and flowers.

It was the eighth day since the beautiful butterfly had laid her eggs. Seven (7) lovely little caterpillars came out of their eggshells. They crawled out and began eating the empty shells. Each small caterpillar went its' own way and started feeding on the leaves and flowers. They love eating leaves and flowers and grow fat from eating a lot of food. Soon the caterpillars will shed their skin as they grow and form a chrysalis then change into a beautiful butterfly.

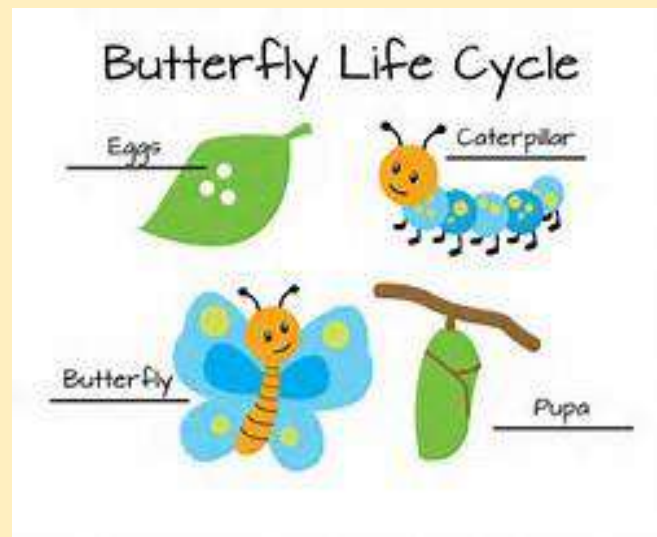
An adult butterfly will eventually emerge from the chrysalis after about one to three weeks. It will wait a few hours for its wings to fill with blood and dry, before flying for the first time. Butterflies can live in the adult stage from anywhere between a week and a year, depending on the species. Butterflies have four wings. Butterflies often have brightly coloured wings with unique patterns made up of tiny scales.



A beautiful monarch butterfly looking for pollen



The caterpillar is a munching machine



This is a life cycle of the butterfly

Unpublished

