Teachers' Kit on Sustainable Land Management and Land Degradation

Prepared by the Capacity Development and Mainstreaming for Sustainable Land Management Project

A Project executed by the Guyana Lands and Surveys Commission and Implemented by the United Nations Development Programme with Funding from the Global Environment Facility

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Table of Contents

Preface

Sustainable Land Management (SLM) is a key piece in the sustainability puzzle. Before we delve into SLM, we need to understand “sustainability” as it sets the framework for SLM and other key concepts such as biocapacity, ecological footprint and more. Additionally, sustainability is THE concept that drives our collective desire for a more balanced, healthy and respectful way of life.

Sustainability: Equitable Development within the carrying capacity of Earth’s Natural Systems

Climate Change, economic turmoil, oil spills, species loss, and global security issues—all front and center in today's headlines—underscore the fact that our world is growing more inter-connected. People and planet are ever more tightly bound into one global system and one destiny yet the data shows we are depleting the very ecological systems and life-support processes upon which civilization depends. To achieve sustainability we must transform how we live and do business on this planet. We need to become self-sufficient in energy, significantly decrease carbon emissions and other wastes, and restore vital natural ecosystems. At the same time, we need to address global poverty, fair access to resources and world security. All this requires transformative leadership, unprecedented adaptability and scalable innovation in our public, private and community sectors, world-wide.

So how does this Teachers’ Kit fit into the sustainability puzzle?

The Teachers’ Kit is a tool built to further embed sustainability within the Secondary School syllabus and, more broadly, our way of life. It is designed to help you, the teacher, empower your students with knowledge, skills and practical tools to help students appropriately address today’s serious environmental, economic and social issues, by keeping sustainability forefront in their minds.

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- Environmental Protection Agency
- Guyana Energy Agency
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- Guyana Forestry Commission
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The SLM Project is appreciative of the invaluable support from the Teachers who participated in the Workshops on the Integration of SLM into the Secondary School Curriculum and supported the preparation of the Resource Guide and Training Video to guide the use of the Teachers' Kit.

Forward – Note to Teachers on the Teachers' Kit

Background

Guyana's National Action Programme to Combat Land Degradation (2006) calls for increased capacity (skills, knowledge and technology) to combat land degradation. Land degradation in Guyana, while perhaps not highly visible at this stage, has been increasing and the potential exists for it to expand, corresponding to an increase in the exploitation of natural resources and coastal erosion. Change in land use has been due to a rapid upsurge in economic activity over the last ten years, in particular the sectors of forestry, mining, agriculture with the expansion in state land leases for agriculture and commercial activities.

Guyana's principal vulnerabilities stem from the low-lying nature of its populated seacoast which makes it vulnerable to flooding from sea level rise, intense precipitation and breaches of the sea defences. Factors which contribute to land degradation are loss of forest and vegetation due to inappropriate logging, forest fires, irresponsible mining and urbanization, improper land management, changing climatic patterns and coastal erosion due to flooding.

This Teachers' Kit with a Resource Guide and Training Video provides teachers with an educational resource that can facilitate the delivery of existing school curriculum. At the same time it will prepare future leaders and citizens with the requisite knowledge, skills and appreciation for enhanced land use and management.

The Kit is an output of the Capacity Development and Mainstreaming for Sustainable Land Management Project implemented under the UNDP-GEF Targeted Portfolio Project for Sustainable Land Management (SLM) in Small Island Developing States and Lesser Developed Countries.

Educational objectives of the Teachers' Kit are:-

1. To raise the visibility of SLM issues and solutions specific to Guyana.
2. To provide Secondary School Teachers with a local educational resource that can facilitate the delivery of existing School curriculum.
3. To provide teachers with a solid foundation on the themes related to land degradation and SLM.
4. To encourage teachers and students to act locally to implement SLM practices.

How to use the Teachers' Kit

The Teachers' Kit comprises a Teachers' Resource Guide and a Training Video. The Kit was prepared for the Integration of Sustainable Land Management (SLM) in Agriculture Science, Biology, Geography and Integrated Science Subjects in the Secondary Schools' Curriculum, an output of the Capacity Development and Mainstreaming for Sustainable Land Management Project.

The Training Video for Teachers provides further guidance on the Parts and Units of the Guide and includes presentations from Teachers on the methodology for teaching various Units in the Guide. The Video is available on a Digital Video Disc (DVD) packaged with each Resource Guide.

The Resource Guide is aimed at secondary school teachers and their pupils. Its content can be used to supplement the delivery of learning objectives in biology, agriculture, integrated science and geography. Relevant objectives are highlighted at the beginning of each unit with the intention that the teacher will adapt the material to specific lesson plans. Teachers can compile a lesson drawing on information presented in several units. To further local relevance, the teacher should encourage students to reflect on their own experiences.

Three Parts, Seventeen Units

The Resource Guide is presented in three sections and contains seventeen units. Part one begins with the introduction of foundation sustainability concepts underpinning SLM. Part two presents information and activities specific to land degradation issues facing Guyana. Part three presents information on SLM practices.

Classroom Activities

These are designed to reinforce the themes and concepts in the units. The guide provides a range of suggestions with the expectation that teachers will bring their own experiences and ideas on successful classroom or school-wide activities. Ultimately, the guide aims to inspire action and interactive real life activities provide a vehicle for action in the school, community and country. Additionally, there is opportunity for Teachers to develop and implement exercises that foster student's empathy and appreciation for the natural environment.

Targeted Secondary School Forms

Teacher delivery of he content is most suitable for Secondary School Forms 1-3 but could also be applicable for Forms 4 and 5.

PART ONE

Part One:
Introduction to Sustainable Land Management and Current Land Management Issues in Guyana

Introduction

The Capacity Development and Mainstreaming for Sustainable Land Management (SLM) Project recognized that capacity development and training to reduce land degradation is important to reduce and combat land degradation. Specifically, this output of the Project aimed to provide a Teachers' Kit to promote capacity development for Teachers and Students.

The expected result is to achieve life-long learning by providing related syllabus content for Agricultural Science, Biology, Geography and Integrated Science Subjects taught in Secondary Schools in Guyana. The Kit comprises a Resource Guide and a Teachers Training Video for further guidance on the use of the Kit.

The Resource Guide of the Teachers' Kit has three (3) Parts with an explanatory of the knowledge and skill outcomes, and each Unit's corresponding Syllabus Sections and Objectives. Much of the contents of Part 1 introduce the topic of land degradation and the need for SLM.

Part 1 of the Kit discusses SLM in the context of:-

- Sustainable Land Management and Land Degradation
- The occurrence of Land Degradation Globally and in Guyana
- Overview of how Land Degradation occurs
- Biodiversity and Ecosystem Services

Part 1 of the Guide introduces the topic of sustainable land management and land degradation, providing definitions of sustainable land management, impacts of land degradation and the importance of ecosystem services. The Teachers' Kit could be enhanced through a commitment by you to make effective use of the Resource Guide and Training Videos.

Teacher's Resource Guide, Part One

Knowledge and Skill Outcomes

KNOWLEDGE, understanding of:

- The concepts of sustainability, sustainable land management, land degradation, biocapacity and ecological footprint
- How land degradation reduces biocapacity through further limiting the earth's resources we have access to
- How land degradation is mitigated and/or avoided through Sustainable Land Management (SLM)

SKILLS, development of:

- Critical thinking and problem solving
- Creative thinking
- Public speaking
- Research skills

Related syllabus sections

- Integrated Science Syllabus
  - Section A, Unit VII, Objective 10
  - Section B, Unit III, Objective 1
- Biology Syllabus
  - Section A, Objective 5.1
  - Section E, Objective 1.2
  - Section E, Objective 2.1
  - Section E, Objective 3.1
  - Section E, Objective 4.1
- Agricultural Science Syllabus
  - Section A, Objective 4.3
  - Section B, Objective 2.1
- Geography Syllabus
  - Section II, Objective 9
  - Section II, Objective 21

Unit 1: Sustainable Land Management and Land Degradation

Objective: *Introduce key concepts of Sustainable Land Management (SLM) and land degradation.*

Land is used and managed for a variety of different reasons such as providing food for people, income for people, housing for people or habitat for animals. Very often, land is managed for more than one of these reasons and others', simultaneously. In fact, it is rare that land is managed for just

one reason even though that may not be immediately apparent. Take a rural village for example, this village not only provides houses, schools, places of worship and hospitals for people but also provides habitat for animals (in the grasses, shrubs, trees and creeks); food for people produced on small farms; and ecosystem services such as natural air and water filtration.

It is challenging to use land for a variety of different activities and ensure that each activity has a minimal negative impact on all other activities. This is where Sustainable Land Management becomes important.

Exercise

Divide the class into small groups and get each group to brainstorm ideas to answer the following questions:

- ✓ In the area between your home and school, what different activities are carried out on the land?
- ✓ What natural activities are occurring?
- ✓ What do these activities provide to you and your classmates?
- ✓ What are the positive and negative impacts of each activity?

Get each group to answer these questions through pictures, diagrams and drawings. Ask all groups to present their findings to the class. Teacher to synthesize and summarize the class's findings.

What is Sustainable Land Management?

Sustainable Land Management (SLM) in its broadest sense is a land management system that balances the needs of people, economies and environments and minimises the negative impacts associated with each land use activity. The needs of people, economies and environment, in terms of sustainability, are defined as follows:

People: In order to be safe and content, people need access to shelter, healthy food, clean drinking water and cultural nourishment.

Economies: A well-functioning local economy will support local people for the long term through the provision of opportunities to earn a decent income and aid the provision of important services such as schools, hospitals and trade centres.

Environment: In order for environments to be healthy and provide a variety of vital ecosystem services to support all life on Earth, for many generations to come, they need to contain a rich array of biodiversity (flora and fauna) and well-functioning ecosystems.

This is one broad definition of SLM; there are many others out there. The World Bank's definition of SLM is as follows:

SLM is a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management to meet the rising food and fibre demands while sustaining ecosystem services and livelihoods.SLM is necessary to meet the requirements of a growing population. SLM involves:

- Preserving and enhancing the productive capabilities of land in cropped and grazed areas; sustaining productive forest areas and forest reserves (potentially commercial and not commercial); and maintaining the integrity of watersheds for water supply and hydropower generation needs and water conservation zones and the capability of aquifers to serve farm and other productive activities.
- Actions to stop, reverse and mitigate degradation – which is increasingly important in the uplands and watersheds, especially those where pressure from resident populations is severe and where the destructive consequences of upland degradation are being felt in far more densely populated areas "downstream".

For the purpose of this Teachers' Resource guide, we have adopted an action oriented definition of SLM namely, "the adoption of land use systems that, through appropriate management practices, enable land users to maximize the economic and social benefits from the land while maintaining or enhancing the ecological support functions of the land resources"

SLM seeks to increase productivity of the land – including traditional systems- to increase resilience to climate change, food security, loss of biodiversity, soil loss and land degradation.

The Global Environment Facility (GEF) asserts that SLM
"requires an integrated approach to natural resources management that takes into account the factors influencing decisions about land use at the local, national, and regional levels."

Natural resources management refers to the management of natural resources such as land, water, soil, plants and animals. This management paradigm, when done well, follows sustainability principles.

Exercise

Divide the class into small groups and get each group to search the internet for definitions of Sustainable Land Management. Ask each group to pick one definition and critique the definition using the following points as guidance:

- ✓ What are the focus points of the definition?
- ✓ What is missing from the definition that you think should be included?

Get each group to present their ideas to the class.

As a class, build your own definition of Sustainable Land Management.

What is Land Degradation?

Land degradation is the significant loss in quality of land and its services that leads to negative impacts on people, the environment and economies. The definition includes surface and underground water contamination (as proposed in the *National Assessment of Land Degradation in Guyana (NALDG).*

As stated in the NALDG, land degradation is inseparably linked to the management of land and natural resources i.e. land management choices and practices will have significant impacts on the quality of the land.

Land degradation is becoming an increasingly significant issue across the globe. Many people impacted by land degradation are already living in poverty. Additionally, land degradation occurs simultaneously with other phenomena, such as global warming and climate change which increase the threat of wiping out unique ecosystems and decreasing species biodiversity including in food and fibre crops.

The World Health Organization (WHO) states:

"Land degradation has accelerated during the 20th century due to increasing and combined pressures of agricultural and livestock production (over-cultivation, overgrazing, forest conversion), urbanization, deforestation, and extreme weather events such as droughts and coastal surges which salinate land."

The NALDG reiterates this point locally and asserts that "a number of complex and conflicting land management issues are beginning to emerge" in Guyana.

Picture of land degradation as a result of unsustainable forestry practices

Exercise

Teacher to guide the class in a discussion on the following points:

- What are some examples of land degradation around school or home?
- How can land degradation negatively impact people, the environment and economies?
- How could one go about addressing these land degradation issues?

Unit 2: The Occurrence of Land Degradation Globally and in Guyana

Objective: *To provide an understanding of the geographical context of land degradation.*

Where does Land Degradation occur?

Land degradation occurs in a variety of different environments across the globe; it occurs in deserts, forests, grasslands, rainforests and flood plains to name just a few examples. Land degradation affects one third of the planet's land surface and threatens the livelihood of more than one billion people in over one hundred countries.

As a regional example, in the Caribbean, the United Nations Environment Programme (UNEP) has identified pollution of coastal and marine environments to be a significant issue. The main cause is untreated discharges of domestic wastewater.

Land Degradation in Guyana

Land degradation is happening here in Guyana too. Recent estimates outlined in the NALDG suggest that in 2008 degraded land accounted for between 150,000 and 160,000 hectares. This spatial distribution is projected to increase to cover between 200,000 and 250,000 hectares of Guyana between 2012 and 2017 (a conservative estimate).

Land degradation occurs in all four geographical regions of Guyana, namely:

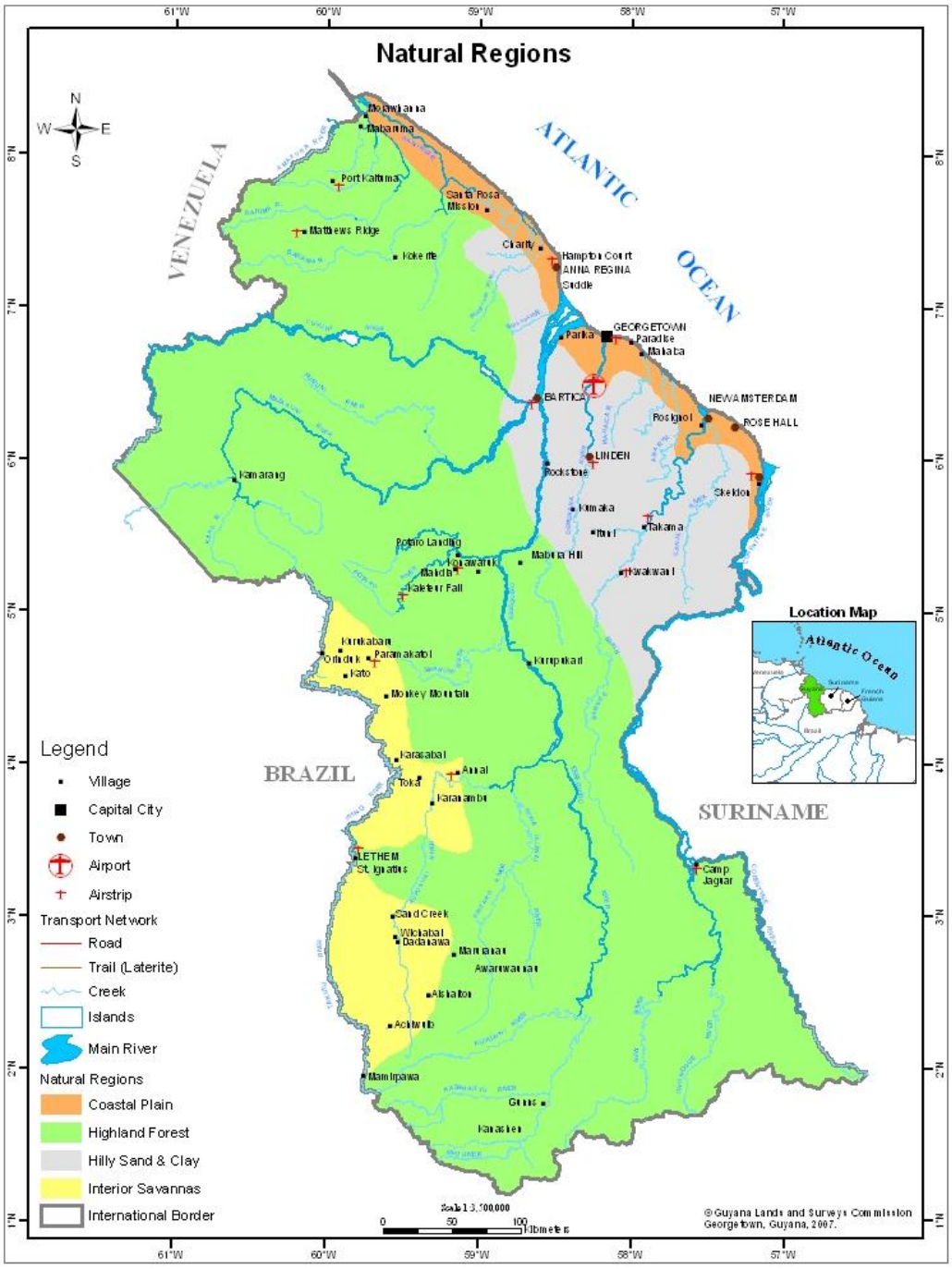
- Coastal region in the north – evidence of mangrove destruction, denuded shorelines, vegetation under stress and intrusion of saline water
- Hilly sand and clay region to the south – evidence of erosion of white sand, structural changes to the undulating terrain (lower gradients of the slopes), deeply weathered rock outcrops, vegetation removed, large man-made craters left from bauxite mining and possible coastal aquifer contamination (no study undertaken yet).
- Forested highlands – evidence of erosion on slopes and along river banks, blockage of rivers and streams, huge mountain-side craters and dry riverbeds.
- Interior savannahs – classed as a potentially vulnerable area.

What makes areas vulnerable?

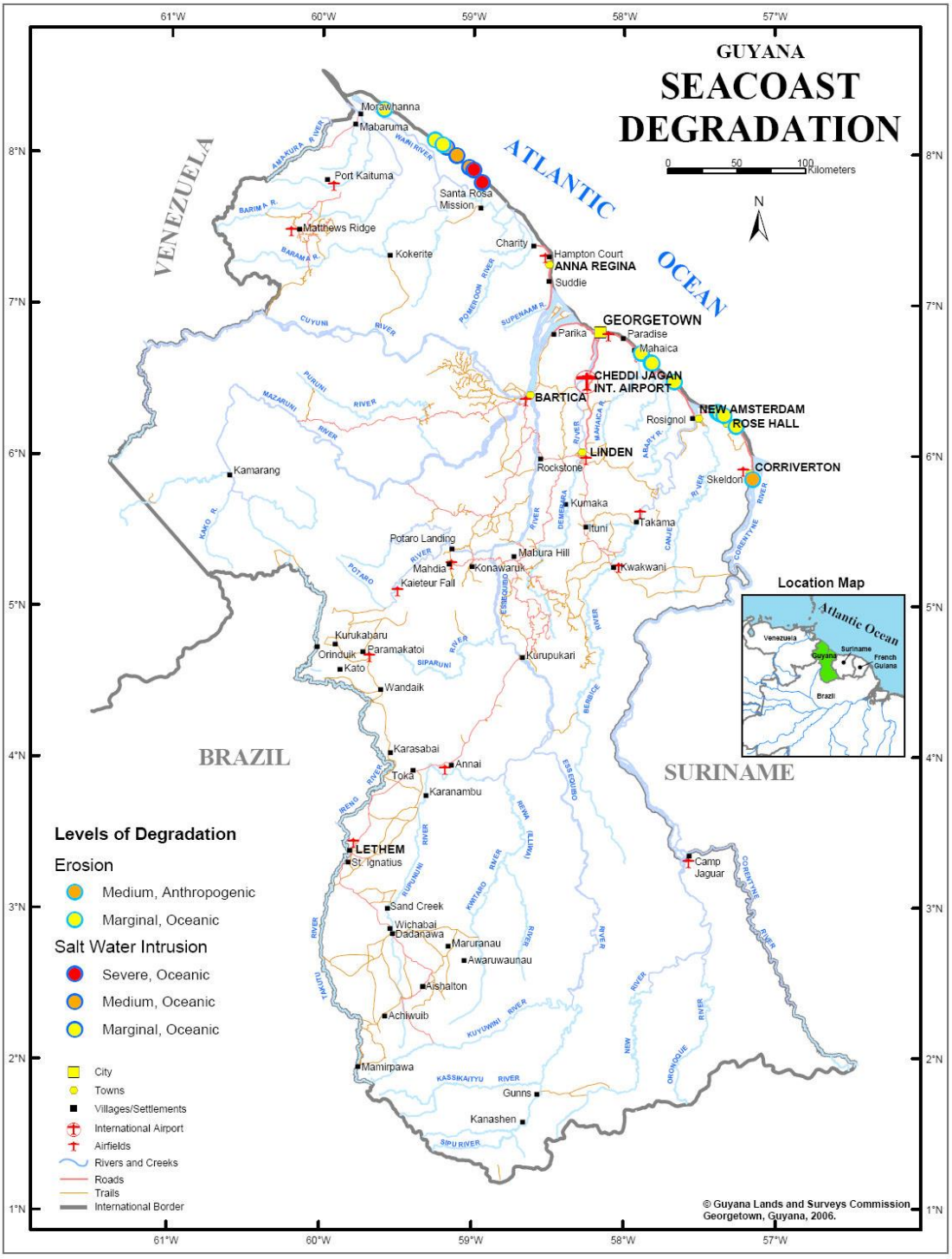
The NALDG states that potentially vulnerable areas in Guyana can be identified on the basis of five main criteria:

- Low-lying areas susceptible to climate change effects;
- Areas currently under threat but cannot be immediately addressed due to lack of technical and financial resources;
- Areas where new infrastructure (roads) exits or being planned;
- Areas where mineral prospecting (gold) or concessions allocated
- Areas where new logging concessions are allocated.

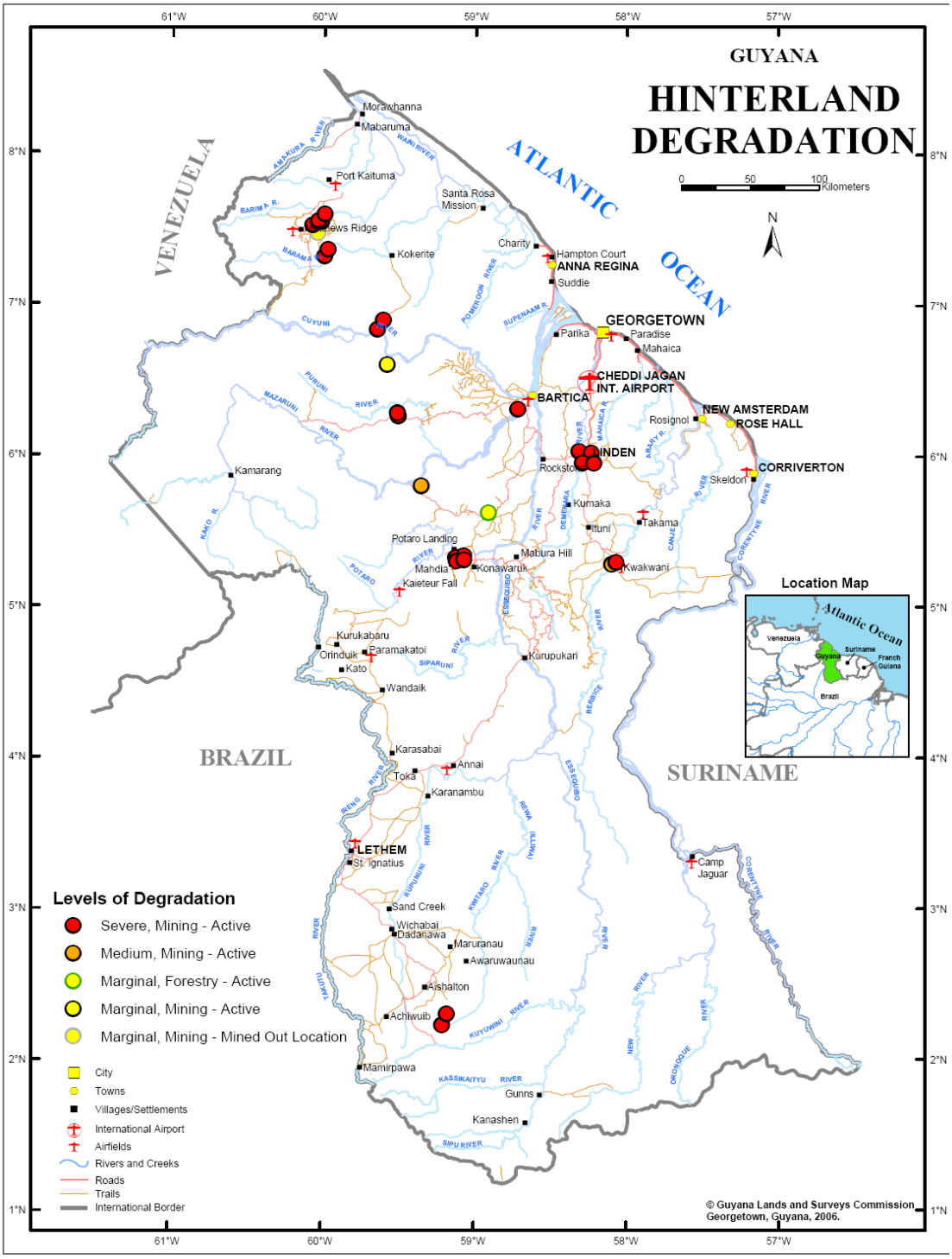
Natural Regions of Guyana



Land Degradation on the Seacoast



Land Degradation in the Hinterland



Why is Land Degradation a problem?

When you add land degradation to the ever increasing list of environmental issues (such as climate change and increasing pollution) permanent changes to nature take place, often in ways that scientists can't (or didn't) predict. In a world with an exploding human population, unprecedented levels of pollution and decreasing access to, and quality of, ecosystem services, land degradation becomes a serious threat to species survival as it significantly **further** decreases the amount of healthy land and its associated services that we have access to.

We are already seeing irreversible impacts...

The United Nations' Environment Program (UNEP) estimates that between 150-200 species of plant, insect, bird and mammal become extinct every 24 hours! The world has not seen extinction rates like these since the dinosaurs vanished 65 million years ago. Species go extinct because their environment changes in ways they are not able to adapt to. Do you think the rapidly growing human population will be able to adapt to increasingly degraded land where ecosystems, water, soil, air and food products are more and more contaminated by pollution and carcinogens?

Land degradation reduces earth's biocapacity by incrementally limiting healthy land and decreasing the quality of services the land provides. With increasing ecological footprints* around the world, can we sustain this path we're on? The scientific community and many others around the globe, think the answer to that question is "no".

Professor William E. Rees from the University of British Columbia tells us that during the 20th Century, the world's:

- *Population quadrupled to 6.3 billion*
- *Energy use increased 16-fold*
- *Industrial .production grew 40-fold*
- *Water use increased 9 times*
- *Fisk catches rose by a factor of 35*
- *Carbon Dioxide emissions increased by a factor of 17*
- *Sulphur emissions increased 13-fold*
- *Other air pollutants rose by a factor of 5*
- *Tropical deforestation and desertification accelerated*

Teachers - see below for more detail on ecological footprints!

Diseases, predators, resource limits and bad luck are all factors in limiting growth. Below are two concepts – Biocapacity and Ecological Footprint – which will help us define ecological boundaries to growth, help us measure our impacts on the land and through these exercises help us see how close we are to breaking through earth's ecological boundaries.

Biocapacity

Biocapacity refers to the capacity of a given biologically productive area to generate an on-going supply of renewable resources and to absorb its spillover wastes.

For more details, see Unit 4!

Ecological Footprint

An ecological footprint (or eco-footprint) is the area of land and water ecosystems that's required, to support a specified human population, by producing resources that the population consumes and treating/recycling wastes that the population produces. When you work out your ecological footprint, it often gives the number of Earths required in order to support the current population if everyone in the world lived like you – used the same amount of electricity, drank and ate the same amount and type of food, travelled as much as you did etc. Guyana's ecological footprint is lower than many other countries'. For example, Canada and the United States of America have much larger ecological footprints per capita. The important point here is that we have only one earth.

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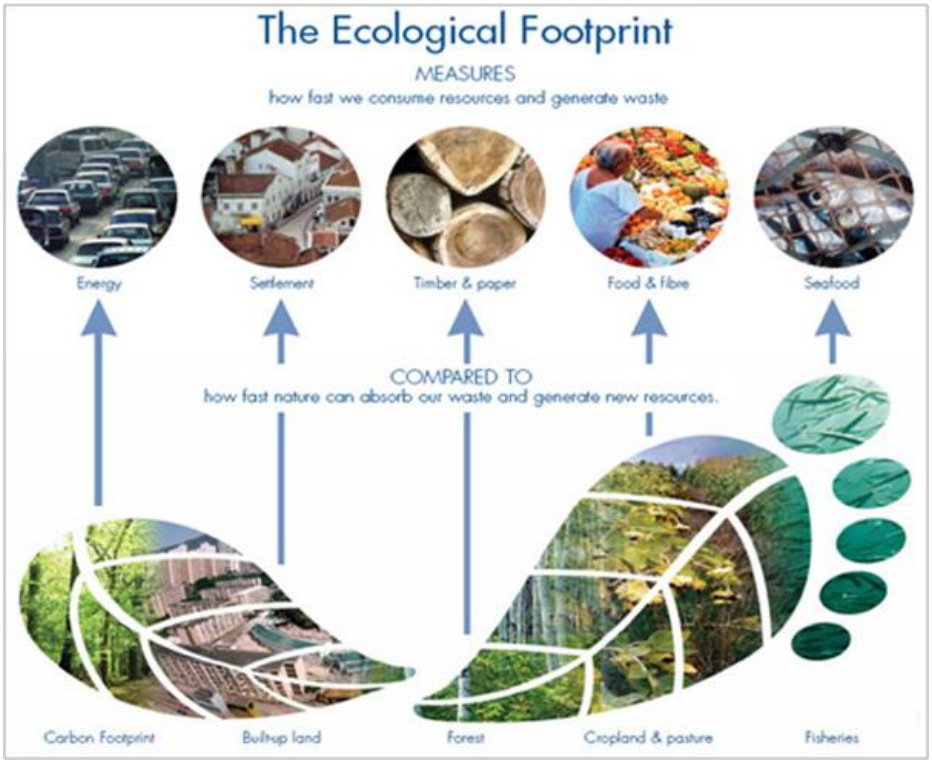


Scientists, mathematicians, geographers and statisticians are behind the development of ecological footprint calculators; there are many reputable calculators publicly available online. It's important to note that the ecological footprint calculator does have

limitations. However, more and more region or country specific calculators are being developed which make the results increasingly accurate.

There are other environmental impact footprint calculators publicly available that provide more detail on the environmental impact of concern. Some popular calculators include: carbon footprint, water footprint and land footprint calculators.

Resource Notes:

There are many ecological calculators available on the internet but there may not be any specific to Guyana's residents. However, going through the questions and analysing the results may still be a useful exercise. One of the best publicly available calculators is the World Wildlife Fund's (WWF) Footprint Calculator, it provides a number of different local calculators for a number of countries. You can find it here: http://wwf.panda.org/how_you_can_help/live_green/footprint_calculator/

A good resource for seeing Country specific ecological footprints compared with their biocapacity is the Global Footprint Network's website, found here: http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_for_nations/

Picture of mangrove forest

Activity for understanding ecological footprints and biocapacity:

Break the class up into small groups.

- ✓ Get each group to use the diagram below and explain how they think land degradation would affect Society, Economy and the Environment.

Get each group to go online and find an ecological footprint calculator and then do the following:

- ✓ Get each group to go through the online exercise and record their individual (or group) results
- ✓ Get each group to analyse their results in terms of what implications there are globally of their results e.g. if everyone in the world lived like you, would we have enough resources to share?

Get each group to find a listing of ecological footprints per country and answer the following:

- ✓ Can you find a listing for Guyana, if not, find a listing of a similar country (e.g. another Caribbean nation)
- ✓ How does this country compare in relation to other nations of the world?
- ✓ Get each group to analyse their results in terms of what implications there are globally of their results e.g. if everyone in the world lived like people in this country lived, would there be enough resources to share?

Get each group to find a listing of biocapacity per country and then analyse the results by asking similar questions as those asked above.

Bring the class back together and facilitate a discussion on the following points:

- ✓ Why do country's footprints differ across the globe?
- ✓ Why does Guyana have a relatively low ecological footprint?
- ✓ Do you think ecological footprint's are growing, if so, why? Where would they be growing the fastest?
- ✓ Why does country's biocapacity differ across the globe?
- ✓ Why does Guyana have a relatively large biocapacity?
- ✓ Are we sharing this biocapacity, how are we doing this?
- ✓ Does land degradation impact biocapacity, if so, how? Provide some examples.
- ✓ Given that the world's ecological footprint is growing, what impact will land degradation impact have on footprints? (Think about the relationship between biocapacity and footprints).

Unit 3: Overview of how Land Degradation occurs

Objective: *To introduce the key sources of land degradation.*

Land degradation is a result of both anthropogenic and natural causes. Some examples of activities leading to land degradation include over farming, polluting of solid, liquid and gaseous waste, flooding, earthquakes and tsunamis. Deciding whether causes are anthropogenic or natural can be challenging! Some scientists argue that some "natural" factors can be directly linked to anthropogenic phenomena such as climate change and global warming as these phenomena are predicted to drive increased storm surges, drought and rising sea levels.

In Guyana, the main sources of land degradation can be split into four categories: unsustainable industrial activity, unsustainable human settlement, weak un-coordinated governance and natural factors. The key issues are as follows:

1. Industrial Activity

- **Mining:** This sector has the most significant impact on land degradation nationally according to the National Assessment of Land Degradation in Guyana. Mining's main industrial impacts relate to the increase of operations size due to improvements in technology and greater geographical reach. Land degradation takes the form of loss of vegetation and top soil and biodiversity loss through destruction of habitat.
- **Logging:** Land degradation occurs through loss of forest due to poor timber harvesting techniques and lack of mechanisation.
- **Agriculture:** Monoculture farming systems, inundation of agricultural lands, indiscriminate use of chemicals and deliberate saltwater intrusion lead to degraded agricultural lands.

2. Human Settlement Issues

- **Human settlement expansion:** This is mainly a problem on the ocean coast where 90% of the nation's population is located. Impacts include destruction of mangrove forests which leave coastal areas much more exposed and prone to flooding plus the loss of species habitat.
- **Improper solid waste disposal:** This leads to pollution of land, air and water which degrades the ability of the environment to provide ecosystem services. This is mainly an issue in Region 4 as there is a high population density.

3. Governance Issues

The following governance issues negatively impact the way the land is managed:

- **Fragmented jurisdictions and poor interagency coordination**: This leads to uncoordinated and weak approaches to land management governance which, by design, will exclude a number of significant land management priorities whether they're economic, social and/or environmental.
- **Lack of policy and weak enforcement of mining and forestry-related regulations**: This can lead to resource exploitation and in the worse case, business incentives to operate inefficiently and unsustainably.
- **Unclear property rights (especially land use rights):** This can lead to resource exploitation, and social issues such as arguments amongst stakeholders.

Natural Phenomena and Events

The following natural phenomena and events can have significant impacts on land:

- One-off severe weather events such hurricanes, floods, tsunamis and severe storms.
- Short to medium term events such as droughts and seasonal weather patterns.
- Long term phenomena such as global warming and climate change, responsible for impacts such as sea level rise.

As mentioned, some natural factors can be attributed to anthropogenic issues (e.g. increased anthropogenic greenhouse gas emissions leading to climate change which is linked to increased frequency and severity of extreme weather events).

For more information on the factors impacting land degradation, see Part 2.

Multi-day activity

Break the class up into four groups. Allocate one of the four geographical regions of Guyana (as outlined in Unit 2) to each group. Get the groups to research and then answer the following questions over the space of a week (allocate one hour per day):

- ✓ What types of ecosystems are prevalent in this region?
- ✓ What types of animal and plant species live in this region?
- ✓ What type of industrial activities take place in this region?
- ✓ What types of natural factors impact land in this area?
- ✓ What land degradation issues do we expect would occur?
- ✓ What is being done to address the land degradation issues facing your region?
- ✓ Is there anything more that could be done, if so explain.

Get the groups to present their work to the class on the last day of the week.

After the presentations, facilitate a class discussion to define the relationship between SLM and land degradation.

There are some serious concerns about land degradation in Guyana but it should be noted, on a global scale, Guyana nationally is not in as dire a predicament than some other countries where land degradation is apparent everywhere and becoming increasingly challenging to reverse and mitigate.

As the world's population expands, ecological footprints continue to grow and land degradation continues, countries like Guyana, with a high level of biocapacity, will become more and more important as they will become increasingly well placed to act as Earth's filters, recycling and purifying systems. Guyana's wilderness areas and well maintained agricultural lands, rich in biodiversity and healthy ecosystems can continue to support life on Earth.

When considering SLM, given that Guyana has a relatively high biocapacity and a relatively low ecological footprint, the following issues will be of importance to Guyana:

- Finding ways to manage areas vulnerable to land degradation, now and into the future, so that biodiversity and ecosystem services are protected; and
- Continuing to develop legislative frameworks, policies and systems that promote the "sale" of Guyana's ecosystem services to other countries and global organization.

The "Great Flood" of 2005

In 2005, three days of torrential rain pelted down on Guyana and a flood hit the country's capital city on January 14, 2005. During these three days, Guyana received 132cm of rain which equates to seven times the average for expected rainfall in the month of January. Regions 3, 4 and 5 were declared disaster areas. Many villages continued to suffer from persistently high waters weeks after the initial flooding as rains resumed towards the end of January. It is estimated that 300,000 people were impacted during the peak period of the emergency; there were 34 reported fatalities.

The flooding caused monumental destruction to Guyana's infrastructure, people, livestock and environment!

Unit 4: Biodiversity and Ecosystems Services

Objective: *To introduce concepts related to ecosystems services and land degradation drivers impacting ecosystem services*

Why is Nature Important?

One of the main realities with biodiversity is that because it is nature, its many services are delivered free. Because of this, we have a tendency not to value what we receive from nature – be it clean air, fresh water, nutrients, flood protection, spiritual beliefs, or some other benefit, like pollination. But things are changing and the value of services provided by nature are being quantified and factored into economic equations. And as this happens, ecosystems degradation will have a material impact on the wealth of a nation. Understanding ecosystems dependencies is of key importance to economic development as well as decisions regarding SLM.

Ecosystems services are the benefits that people and economies gain from nature. Biodiversity underpins the proper functioning of ecosystems and ensures the delivery of ecosystems services.

Forested area in Region 1

Categories of Ecosystems Services

In 2001, the United Nations initiated the Millennium Ecosystems Assessment (MEA) study involving over 1,300 scientists from around the world to assess the health of the world's ecosystems. According to the MEA there are four categories of ecosystems services, provisioning, regulating, cultural and supporting services.

Provisioning Services: provision of goods or products such as water, fish or fibre.

Regulating: Ecosystems functions such as climate regulation (carbon sequestration) and the protection of coasts from erosion and extreme weather conditions.

Cultural services: non-material benefits such as recreation, aesthetics and spiritual beliefs.

Supporting: fundamental processes necessary for the production of all other ecosystem services such as photosynthesis and nutrient recycling that support the other services.

We are at the very early stages of understanding the value of these ecosystems services and the opportunities they create in terms of economic development and land use planning.

Ecosystem services: provisioning, regulating, cultural and supporting services

Ecosystem Services in Guyana

Forest Ecosystem Services and Climate

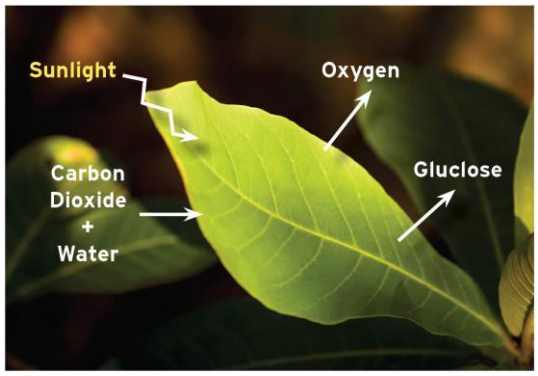
As an example of local ecosystem services let us consider Guyana's forests. Guyana has 18.39 ha of biologically diverse tropical forests. These forests which have traditionally provided high value tropical export logs are now being valued for their climate regulating services. The GRIF fund has been set up to receive up to US$250 million from Norway until 2015 based on an independent verification of Guyana's deforestation and forest degradation rates.

Carbon Sequestration in Forests

So how does the forest act as a carbon sink? Carbon is held in the terrestrial system in vegetation and soils. Biological growth, such as trees, captures carbon from the atmosphere and distributes it within the terrestrial system. Decomposing vegetation and respiration releases carbon back to the atmosphere.

Plants use the process of photosynthesis to combine atmospheric carbon dioxide (CO_2) with water to incorporate carbon atoms into their cells. In doing so, they not only feed themselves but also release oxygen into the atmosphere as a byproduct of photosynthesis. In this example, photosynthesis is a "**supporting**" ecosystem service as it is necessary for the production of other ecosystem services, providing oxygen, an element essential for most living organisms.

Forests are a vehicle for capturing or sequestering carbon and also act as carbon reservoirs. A young forest when growing rapidly can sequester relatively large volumes of additional carbon proportional to the forest's growth in biomass. On the other hand, an old growth forest acts as a reservoir holding large amounts of carbon even if it is not experiencing net growth. Thus, a young forest holds less carbon but is sequestering additional carbon over time. An old forest may not be capturing new carbon but can continue to hold large amounts of carbon as biomass over a growth cycle of many decades. In this example, Guyana's forest climate regulation services are a "**regulating**" ecosystem service as at a global scale, they play an important role in climate by sequestering or emitting (in the case of deforestation) greenhouse gases.



Diagrammatic depiction of photosynthesis

According to the Guyana REDD+ Investment Fund (GRIF) Guyana's forest environmental climate services avoid 1.5 gigatons of CO_2 and are valued at $ US 40 billion. In other words, Guyana's forest act as a world carbon sink and the international community is prepared to pay Guyana to maintain its low level of deforestation.

Exercise

Classify the following into provisioning, regulating, cultural and supporting services.

- ✓ **Knowledge systems: ecosystems influence the types of knowledge developed by different cultures**
- ✓ **Pest regulation: ecosystems changes affect the prevalence of crop and livestock pests and diseases**
- ✓ **Water regulation: the timing and magnitude of runoff, flooding and aquifer recharge**
- ✓ **Biochemical, natural medicines and pharmaceuticals: many medicines, biocides, food additives and biological materials are derived from ecosystems**
- ✓ **Soil formation: because provisioning services depend on soil fertility, the rate of soil formation influences human well-being**

Build a list of ecosystem services specific to Guyana under each of the four categories

Ecosystems Services and Human Well-Being

Ecosystem processes and services are critical to human well-being and livelihoods and increasingly, communities, governments and business are aware of the interrelationship between the state of ecosystem services and economic and social sustainability. According to research associated with the MEA, there are five aspects of human well-being and correlating values associate with ecosystems service provisions:

Security: a safe environment, resilient to ecological shocks, secure rights to ecosystem services.

Basic material for a good life: access to resources for a viable livelihood including food and building materials or income to purchase these.

Health: access to food, water, energy, clean air and nutrition

Good social relations: aesthetic, recreational, spiritual and cultural value, as well as avoidance of tension associated with resource scarcity.

Freedom and choice: the ability to influence decisions regarding ecosystems well-being.

Persistent reduction of ecosystem services will result in loss of human well being. It is often the poorest and most vulnerable that are most affected by the degradation or loss of ecosystem services or biodiversity.

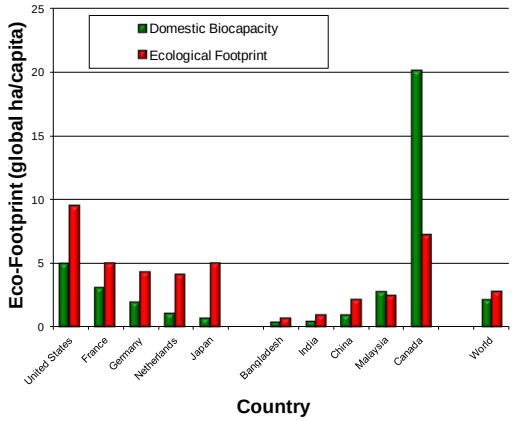
Bio-capacity

The European Commission states: “biocapacity represents the bulk of the biosphere’s regenerative capacity. It is an aggregate of the production of various ecosystems in a certain area (e.g. of arable land, pasture, forest, productive sea). Some of it may also consist of built up or degraded land.”

Many scientists agree that there are limits to growth – species population and/or economic growth. This is not a new concept and humans have borne witness to this fact since time began, not only through extinctions of other plant and animal species but in human agricultural societies also. Take for example, the former Polynesian society of Easter Island, situated in the Pacific Ocean. Archaeologists and scientists are not able to say with 100% certainty that

over-population was the most significant contributing factor in this society's tragic demise but it is highly likely given the facts. The inhabitant population grew to an unsustainable level whereby eventually, all trees on the island were cut down to make room for increased agricultural practices. Shortly after the last tree was cut down, there was no supply of timber for ocean-going canoes and food supplies dwindled; the society crumbled. The population diminished, sacred practices were slowly abandoned, warfare between tribes flourished, poverty and starvation were rife.

In the case of Easter Island, a significant limit to population growth was space for agricultural land that when farmed, produced foods and fibres necessary to sustain human life. Space for agricultural land is just one biocapacity limit; there are a few others which, when combined, determine limit



s to population

Biocapacities and Ecological Footprints of Selected Countries Compared to the World Averages (2005 data)

growth based on the type and quantity of resources (e.g. drinking quality water, fresh air and healthy soil) a population needs to have a good quality of life. The Stockholm Resilience Centre, based at the Stockholm University, has developed nine "planetary boundaries", they are: stratospheric ozone layer, biodiversity, chemicals dispersion, climate change, ocean acidification, freshwater consumption and global hydrological cycle, land system change, nitrogen and phosphorous inputs to the biosphere and oceans and atmospheric aerosol loading. All of these planetary boundaries have critical levels (some of which are know, others we do not know), that when reached, will seriously impact human health and livelihood, not to mention the impact on other species and systems.

Biocapacity and the Wealth of a Nation

If we compare the biocapacity of regions, or countries, that is - the capacity of a given biologically productive area to generate an on-going supply of renewable resources and to absorb its spillover wastes, not all nations are created equal.

Land Management and Ecosystems Services

Humans are changing – and to some extend irreversibly - the diversity of life on earth. According to the Millennium Ecosystems Assessment (MEA) over 60% of the world's ecosystems are in decline. Valuable services are threatened by a number of direct and indirect drivers, including land use change, resource exploitation, climate change and a growing world population.

Land cover change is considered a direct driver associated with ecosystem conditions and degradation. A direct driver unequivocally influences ecosystem processes. Humans change land to alter the nature of ecosystem services produced by that land. Sometimes the change is intentional, such as converting grassland to plant biofuel crops. In other cases, land conversion is unintentional, for example, salinization is the unintended consequence of irrigation that does not have proper drainage.

Land degradation is defined as the reduction or the loss of biological or economic productivity of lands, primarily caused by human activity (as well as climate).

The Millennium Ecosystem Assessment identifies four types of land conversion, deforestation, dryland degradation, agricultural expansion and urban expansion. We will discuss these in subsequent chapters as these relate to the region and Guyana.

Exercise

Discuss intended and unintended land cover change in Guyana and related changes to ecosystem processes (picture on Mining on the upper right could be used to start the discussion)

Discuss the role of trees and forests (picture on the watershed area in the forest could be used for this discussion)

Resources

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PART TWO

Part Two:
Introduction to Sustainable Land Management and Current Land Management Issues in Guyana

Teacher's Resource Guide, Part Two

Knowledge and skill outcomes

KNOWLEDGE, understanding of:

- Key factors contributing to land degradation locally in Guyana
- Geographical distribution of land degradation in Guyana
- The relationship between climate change and land degradation
- The consequences of land degradation in terms of the sustainability paradigm

SKILLS, development of:

- Critical thinking and problem solving
- Creative thinking
- Public speaking and performance
- Research skills

Related syllabus sections

- Integrated Science Syllabus
    - Section B, Unit II, Objective 4
    - Section B, Unit III, Objective 7
    - Section C, Unit II, Objective 3
- Biology Syllabus
    - Section C, Objective 5.2
    - Section E, Objective 4.1
    - Section E, Objective 5.1
    - Section E, Objective 5.2

- Agricultural Science Syllabus
  - Section A, Objective 2.1
  - Section A, Objective 2.2
  - Section A, Objective 4.3
  - Section B, Objective 1.6
  - Section B, Objective 1.14

- Geography Syllabus
  - Section II, Objective 6
  - Section II, Objective 7
  - Section II, Objective 8
  - Section III, Objective 6
  - Section III, Objective 13
  - Section III, Objective 16
  - Section IV, Objective 1
  - Section IV, Objective 5
  - Section IV, Objective 8
  - Section IV, Objective 9

Introduction

According to The Millennium Assessment, the key land degradation issues of global concern are deforestation, dryland degradation (i.e. land degradation in dry land areas), urban expansion and agricultural expansion. These issues are of concern locally in Guyana too. As outlined in Part 1, Unit 3, land degradation is a result of both anthropogenic and natural causes. The main sources of land degradation can be categorized as follows:

- **Industrial activity:** Land use change (also called land conversion) brought about primarily by the mining, forestry and agriculture sectors and unsustainable practices undertaken by these sectors.
- **Human settlement:** Land use change through urban expansion, sub-optimal human settlement patterns and associated issues such as improper solid waste disposal.
- **Governance issues**: Weak legislative, policy and monitoring/enforcement frameworks resulting from little to no coordination between relevant government departments such as Environment, Industry and Human Settlement.
- **Natural phenomena**: Naturally occurring events such as floods, hurricanes, droughts and climate change. Note: it can be argued that some "natural" factors can be directly linked to anthropogenic phenomena.

The Millennium Assessment highlights the following key indirect drivers of land degradation:

- **Global population growth:** Driving demand for more industrial activity (more food, fibre and products) and land for conversion to human settlement.
- **Increasing consumption, production and globalization:** Not only is increased population driving this trend but people around the world (and increasingly in emerging economies such as India and China) are demanding a lot more than they used to. To feed the increased demand for products, production has increased often in global ways accessing resources, labour, machinery and business expertise from all corners of the world.
- **Economic policy distortions:** Unbalanced taxes and subsidies lead to unbalanced impacts on the market through distortion of "real" pricing (i.e. pricing that includes all actual costs) and therefore consumer demand.

This part of the Guide deals primarily with the direct sources of land degradation i.e. industrial activity, human settlement, governance issues and natural phenomena. Land degradation issues are detailed alongside the description of land degradation sources.

Remember the "sustainability trio" introduced in Part One of the Guide? We can analyze land degradation through this framework by thinking about land degradation impacts on economies, the environment and people. For example, land degradation impacts on the "sustainability trio" include:

- **Economies**: Economies are impacted by land degradation through damage to food crops, fibre crops and infrastructure.
- **Environment**: The environment (or "nature") is impacted by land degradation through loss of biodiversity, ecosystem services and biocapacity due to disruptions in micro-climates, species habitats, species reproduction activities and species ability to find suitable food sources.

Flooding in Region 9

- **People**: People are impacted by land degradation through damage to settlements due to sea level rise or flooding for example; impacts on human health through decreased nourishment from food and increased pollution in water and air; decreased access to food; increased poverty through loss of livelihood and/or income and; potentially increased conflict of recourse scarcity.

Unit 5: Industrial Activity: Agriculture

Objective: *To provide an understanding of the contribution from industrial activity and agriculture to land degradation globally and in Guyana.*

Introduction to Impacts of Industrial Activity

Industrial activity, especially in the mining, forestry and agriculture sectors is behind significant land conversion. Land conversion can bring about change from a relatively stable natural landscape to another type of landscape serving an industrial purpose. When land is converted like this, and there is no concern for protecting ecosystem services, as is often the case, there is a significant loss in ecosystem service quality. Land conversion combined with unsustainable industrial practices is the cause, or exacerbating agent, of many land degradation issues.

Sector specific industrial practices and associated land degradation challenges are outlined in Units 5, 6 and 7 below.

Agriculture

Agricultural produce contributes around 30% to Guyana's GDP i.e. agriculture is a very important economic sector. The vast majority (95%) of Guyana's agricultural activity is conducted on the coast because of the favourable climatic conditions and richer soil. In order to make the shift to more sustainable modes of agriculture, it is important to understand current practices threaten the longevity of the sector and the quality and quantity of produce.

The following are identified as key agricultural land degradation issues in Guyana:

- **Mono-cultural farming practices:** While mono-cultural farming practices increase the yield of certain economically viable crops in the short to medium term, they decrease the land's and plant's ability to naturally fight pests and diseases as biodiversity (which incorporates natural pest deterrents and disease prevention mechanisms) is purposefully decreased. This generally leads to increased applications of fertilizers and chemicals in order to bolster plant growth and kill/deter pests. Increased and sustained use of artificial products can have devastating effects on ecosystem health and services in the medium to long term.
- **Decrease in soil quality and loss of soil cover:** Decreases in soil quality and loss of soil altogether, particularly topsoil, threaten the continued productivity of agricultural lands. The soil composition and microbial processes that soil undertakes are severely impacted through loss of vegetation and application of chemicals and fertilizers. Soil is also being lost through exposure to the elements, through loss of vegetation, and erosion.
- **Inundation of agricultural lands:** The artificial practice of inundating rice fields leads to loss of soil, as soil is picked up in the stream of water and deposited elsewhere, and leaching of nutrients

What is Sustainable Agriculture?

The Organic Initiative for a Sustainable Caribbean defines sustainable agriculture as an activity (or way of life) which cultivates clean and pure foods and fosters healthy relationships and communities in the Caribbean. Other organizations add to this definition by stating that sustainable agriculture preserves or improves ecosystems and their functions and services so that future generations have access to the same or better conditions than today's people.

from the soil, as the water collects nutrients as it moves through the soil. Issues are increased when saline water is accidently used to inundate rice fields which happen on occasion; this is explained in more detail below.

- **Deliberate salt water intrusion:** This is typically done to access water for aquaculture farms. This practice has been known to contaminate fresh water irrigation channels and lead to soil degradation when saltwater is used to irrigate crops. One example of the soil degradation encountered is the change in soil chemical characteristics when the soil's pH level is lowered for example.
- **Significant use of chemicals:** Chemicals are used in an attempt to replenish degraded soils, combat pests and weeds and bolster crop growth. Extensive use leads to decreased quality of soil, eutrophication of drainage canals and penetration of "pollution" to areas outside the immediate crop growing area.
- **Animal production practices:** Livestock grazing can lead to overgrazing, compaction and erosion. The scale of impacts directly on the soil and more broadly, the agricultural ecosystem, varies according to the fragility of the land being grazed and the number and type of animals grazing. With the global livestock sector growing faster than any other agricultural sub-sector, buoyed on by increasing consumer demand, this is a major concern!

Farm land definitions:

Arable land: Refers to land under temporary agricultural application for activities such as growing crops, provision of meadows for pasture or market and kitchen gardens.

Permanent crops: Refers to land being used to grow long standing crops that have a long re-planting cycle such as cocoa, rubber and coffee plus permanent pasture. This category excludes trees grown for wood or timber.

Given the significance of these issues, you have to ask, what is the quality of farm land in Guyana is like? The NALDG estimates that the majority of arable land available in Guyana is degraded, albeit to varying degrees.

Introduction of synthetic phosphorous and nitrogen:

As outlined in the Millennium Ecosystem Assessment, a regular part of modern day agricultural practice is to add synthetic supplements of nitrogen, phosphorous and potassium to promote crop growth and boost food production. Demand for food is growing and many agricultural land's soils do not provide enough of the vital nutrients necessary for plant growth.

Nitrogen and phosphorous are the nutrients of most concern as when applied, they are not all taken up by the croplands i.e. there is significant "leakage" to a much larger area than where they are applied. This "leakage" has the ability to impact ecosystems negatively.

The impacts to plants, currently know (i.e. scientists readily acknowledge that there could be impacts currently unknown to scientists), include:

- Decreased quality of water, often impacting drinking quality water
- Eutrophication of freshwater and estuarine ecosystems
- Hypoxia in coastal marine ecosystems
- Nitrous oxide (N_2O)emissions further contributing to climate change
- Air pollution through NO_x (nitric oxide and nitrogen dioxide) in urban areas

Water quality definitions:

Eutrophication is a process whereby plant growth increases too fast and degrades the water quality. It can lead to: noxious algal blooms, increased aquatic plant growth, oxygen depletion and reductions in ecosystem services such as nutrient cycling.

Hypoxia is the term used to describe the decrease in oxygen in water bodies. It can lead to deaths of fish and other animal species.

Eutrophication and **hypoxia** significantly limit current and future possible uses of the water body. For example, the productive capacity of fisheries is seriously reduced and use of the water for town drinking supply or for industry's use is impacted as the quality of the water is significantly degraded.

Invasion of alien species

Not aliens from another planet! But just as worrisome....

Sometimes the introduction of non-local species is good, for example, most food is produced from introduced plant and animal species. Other times, non-local or alien species are introduced to regions where they thrive and out-compete local species leading to, in the worst case, loss of local plant and animal species. A good example of this is the introduction of the Indian mongoose to the Caribbean for the purpose of controlling rats and snakes. The Mongoose has become a pest threatening indigenous populations such as parrots and sea turtles as eggs are high on its preferential diet.

Unit 6: Industrial Activity: Forestry

Objective: *To provide an understanding of the contribution from industrial activity, namely forestry, to land degradation globally and in Guyana.*

As formally recognized in Guyana's Forest Policy, forests provide valuable ecosystem services such as protection of soil from erosion, regulation and purification of water supplies and environmental stability. That is why significant destruction of forests, i.e. deforestation, is of serious concern for people, economies and the environment. We recognize that forests also provide economically valuable resources such as timber and spaces for activities such as ecotourism. There is a way to manage forests sustainably to ensure long term access to forest products and services; we will discuss this further in Part 3. This Unit aims to deal with the unsustainable forestry practices currently taking place.

Definitions from the Millennium Project

Deforestation: The process of converting forested land to some other land type by removing tree canopy cover

Afforestation: The conversion from some other land use to forest

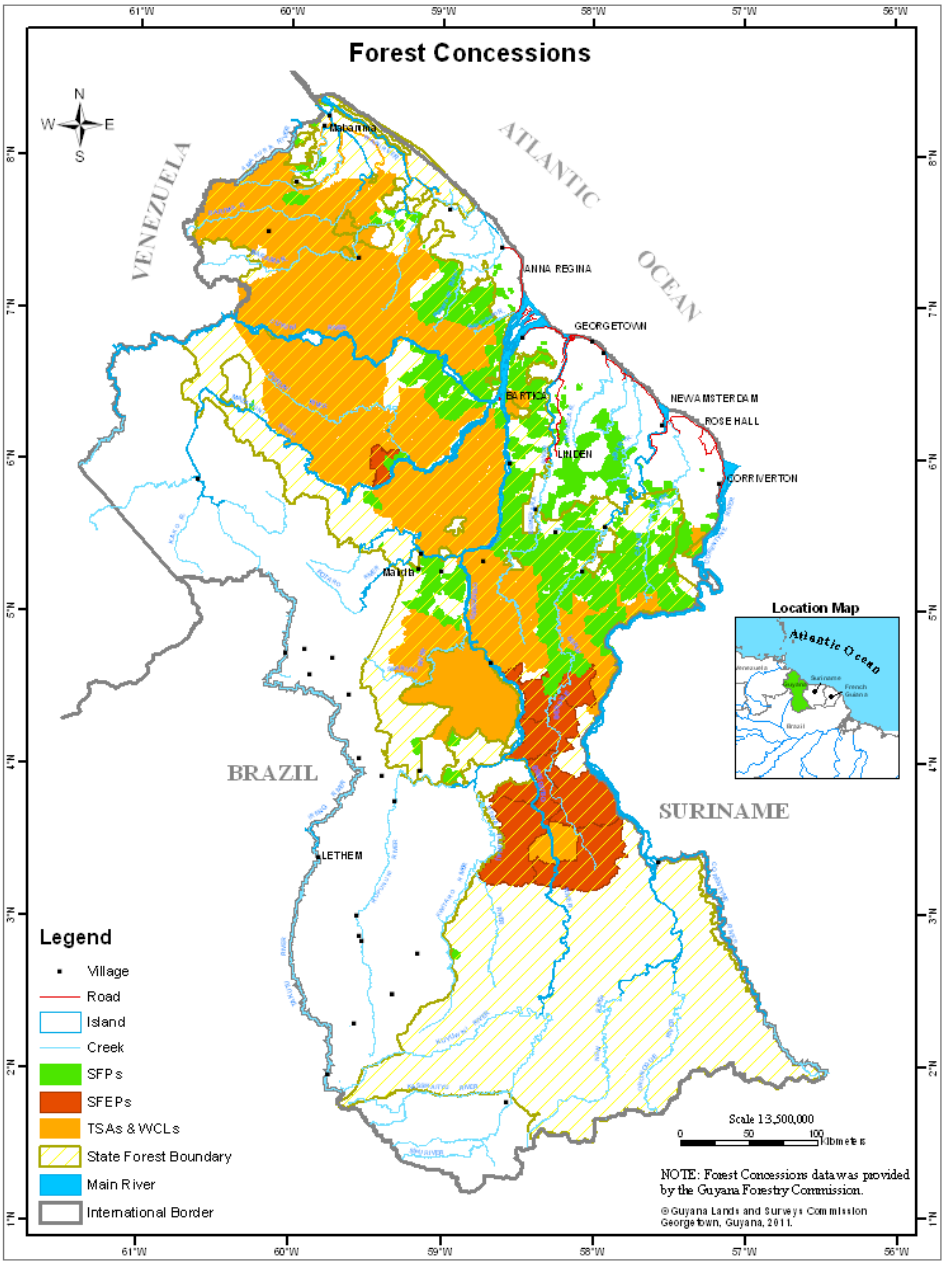
Reforestation: Afforestation on land that at some point in the past was forested

Forestry activities

Deforestation is of significant concern close to home, specifically in South America and the Caribbean; as the Millennium Project states, *"deforestation and forest degradation affect 9% of the world's remaining forests, nearly half of which are in South America. Deforestation has been more extensive in the tropics over the past few decades."*

The forestry industry in Guyana consists primarily of logging and sawmilling operations. The industry comprises of low capital, labour intensive operations and larger capital intensive operations. The map below depicts the spatial distribution of different types of forestry concessions (2011) in Guyana.

Overview of Forest oncessions



The NALDG highlights the following forestry practices of key concern regarding land degradation:

- **Poor harvesting techniques:** Poor harvesting techniques, such as over-intensive harvesting, particularly on slopes, and skidding practices lead to major impacts on the soil including alteration of its physical properties and erosion. Additionally, these practices are a major cause of movement of soil particles into the waterways.
- **Increased development and use of forestry infrastructure and machinery:** Development of more and more poorly designed and constructed roads and trails are in themselves a problem as they cause erosion but they also open access to previously inaccessible areas. Increased access to forests has been linked to "rapid" depletion of the genetic composition of forest species i.e. decrease in biodiversity and consequently decreased ecosystem services provisions.
- **Growth in the industry:** Growth in the industry has been instrumental in improving the financial economic performance of the forestry industry. However if triple-bottom line accounting took place (i.e. environmental costs were included in the economic analysis) the outlook would change significantly as growth has lead to increased intensity of unsustainable practices and increased access to previously inaccessible forestry areas.
- **Traditional market preferences and weak enforcement driving poor practice:** A near-absence of marketing of technically adequate timbers, and a Guyana Forestry Commission (GFC) which does not insist that loggers follow best international practices means that only around 60 of Guyana's 1,000 tree species are commercialized and only a half-dozen are really favoured. Consequently, harvesting in the natural forest is highly selective. Some of the most preferred timbers grow in small areas of particular combinations of soil type, topography and water availability. These areas – known as "reefs" – are especially prone to being over-harvested because the GFC does not insist on observance of its own between-tree distance rule: there should be 10 metres between stumps of felled trees (this distance rule has a sound basis in research by the Tropenbos-Guyana programme in the 1990s).
- **Intensive harvesting in reefs:** Because of the reasons outlined above, intensive harvesting of trees is undertaken in reefs. This results in patchiness of forest cover i.e. considerable areas where preferred timbers do not grow and no harvesting has been done, and areas of harvesting of scattered trees. Patchiness of forest cover greatly complicates estimation of damage from logging and also carbon dioxide emissions attributable to logging and land use change.
- **Illegal logging practices:** There is an absence of hard data related to illegal logging in Guyana however it is known to take place. To estimate the scope of illegal logging, a default factor was developed and is outlined in the "Guyana REDD+ Monitoring Reporting and Verification System Interim Measures Report" developed by the Guyana Forestry Commission and Poyry Forest Industry. The factor equals 15% of the legally harvested annual rate or 62,720m^3 harvested per year (the legal harvesting rate is set at 418,100m3).

Definitions from the UNEP Caribbean Environment Programme:

Erosion is a phenomenon resulting from the action of the wind (wind erosion) or from water (hydraulic erosion) that brings about the removal of top soil and the degradation of rocks.

Sediments are materials of varying size and mineral and organic origin.

Sedimentation is the process of deposition of sediments into a liquid forming a suspension or solution.

A word from the UNEP Caribbean Environment Programme:

*The effects of changes to **erosion** and **sedimentation** patterns will depend on whether the change results in an increase or decrease in sediment availability. Both effects have various **physical and chemical consequences for water quality and aquatic ecosystem health**. Sedimentation effects are usually local, but transboundary impacts may occur where major river systems form a common border and where littoral currents carry inputs across international boundaries. Examples of this in the Wider Caribbean include the impacts of the Mississippi River in the Gulf of Mexico and the Orinoco, Amazon and Magdelena Rivers in South America.*

The impacts of unsustainable forestry activities on the forest ecosystem include:

- Creation of large patches in the canopy
- Decrease in diversity of tree species i.e. loss of biodiversity
- Division of the habitat (i.e. breaking habitat patches up into pieces) of forest animal species which can impact ecosystem services depending on the magnitude of disruption to habitats.

These impacts, in turn, significantly decrease the ability of the forest to provide habitat for species and ecosystem services such as stability of soil, purification of water, soaking up pollution (such as greenhouse gas emissions) and provision of products into the future. This will be discussed in greater detail in Unit 9.

Exercise:

Step 1: Divide the class into four groups and allocate the following identities:

1. Green Timber Incorporated – employees of this logging operation

2. Wildlife researchers - a group who has an interest in the wildlife's needs

3. Forest community - a community living in the forest

4. Government - a group of Government officials who have competing interests in environmental health, economic growth and wellbeing of the citizens.

Step 2: Provide the class with the following scenario:

Scenario: Green Timber Forest Incorporated (GTFI) have been awarded a State Forest Exploratory Permit (SFEP) to carry out works in the Upper Essequibo and Berbice area within Region Six. The concession encompasses 140,000 hectares of forest bordered by the Corentyne, Essequibo and Berbice rivers. The nearest communities to the concession area are Apoteri (80km), Rewa (112km) and Crash Water (160km), all situated on the right bank of the Rupununi River.

GTFI claims that increased access to this area will lead to business opportunities for harvesters and developers of non-timber forest resources. It is true that proposed activities could provide economic benefits but it is likely to have negative impacts on the wildlife and local forest-dwelling communities.

The Government has succumbed to public pressure, based on community members, primarily Wildlife researchers and forest communities voicing their concern over possible negative impacts of this activity, and is now in the process of re-assessing the granted concession.

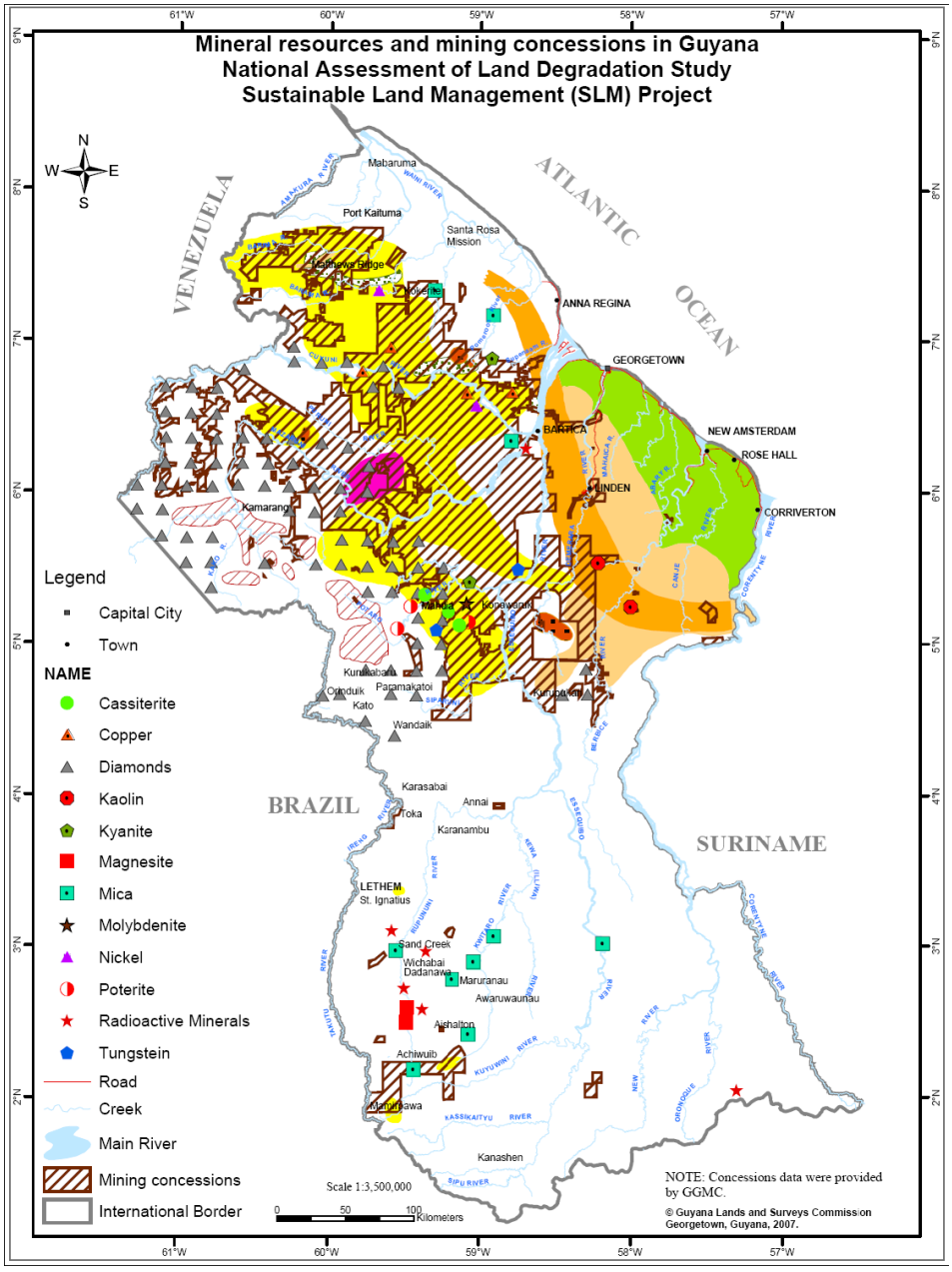
Step 3: Get each group to brainstorm the likely impacts (positive and negative) of SFI's proposed activities for around 5 minutes.

Step 4: Bring the groups together for a class Debate to discuss impacts of the proposed activities, getting each group to maintain their allocated identities. The Teacher's role is to Chair the Debate.

Unit 7: Industrial Activity: Mining

Objective: *To provide an understanding of the contribution from mining, to land degradation globally and in Guyana .*

Guyana is a country rich in mineral deposits sporting a large diversity of minerals from gold, diamonds and bauxite to industrial minerals and base metals such as kyanite, feldspar and uranium. The rich mineral deposits attract two types of mining operations: artisanal (small-scale or subsistence mining) and larger-scale business operations. The map below shows the spatial distribution of mineral resources and mining concessions in Guyana.



Mining activities are carried out on land at every stage in the mining cycle namely exploration, construction, operation, closure and post-closure. The impacts to land vary from minimal during the exploratory stage (for example from small scale on-the-ground activity) to significant during the construction stage (from, for example, vegetation clearing and; building infrastructure such as roads, power transmission lines and pipelines). The type of mining method also greatly determines surface land impacts, as detailed here:

- **Underground mining:** As the mines are underground, they have a relatively small associated surface footprint.
- **Open pit mining:** These mines usually deepen and widen throughout their life which is associated with increasing land surface impacts over time.
- **Open-cast mining:** These mines typically have the greatest land surface impact footprint.

All types of mining can have other environmental impacts, not necessarily apparent on the land's surface such as ground and surface water contamination and soil contamination. An assessment of the Mazaruni, Potaro and Cuyuni mining regions in Guyana, which account for 87% of licensed dredging operations, show visible signs of soil, biological and water degradation. The degree of degradation varies from moderate to severe, depending on location, even within mining areas.

Direct causes of land degradation from larger scale mines include:

- **Improper waste disposal and use of hazardous chemicals:** This practice directly negatively impacts soil and water quality often "leaking" into surrounding areas outside of the immediate waste disposal site.
- **Unsustainable tailings pond storage and management:** Tailings ponds, consisting of sand, clay and rock deposits have been observed to be dumped directly into waterways, constituting a breach in mining regulations as this practise is highly detrimental to water quality.
- **Lack of reclamation activities:** Currently, there is little to zero reclamation activity (such as re-planting vegetation) taking place by miners. This means that "recovery time" for the ecosystem, after mining activity has ceased, is significantly increased.
- **Increasing mobility of miners and their equipment and machinery:** Access to previously inaccessible areas is opening up, as is happening in the Forestry industry. Increasing access is linked to increased unsustainable mining activities, as outlined above, and therefore increased land degradation issues.

Environmental impacts of artisanal mining include:

- **Increased practice of dredging:** Mineral deposits found in river beds are close to being totally exhausted so local mining is increasingly practiced through land dredging. This practice requires the removal of vegetation and often the top layer of soil from the area to be dredged.
- **Release of mercury into the environment:** Airborne elemental mercury is released in artisanal gold mining practices. This has implications for air quality as mercury pollutes the air.

Remember, there are ways to reduce, reverse and avoid environmental impacts of mining. These are discussed in Part 3 of the Guide.

According to the Interim Measures Report, released on October 31, 2010 by the Guyana Forest Commission and Poyry Forest Management Consultants, pertaining to 15 million ha of a total of 18 million ha of Guyana's forest, deforestation rates between 1990 - 2009 averaged 3,800 ha per year representing a rate of 0.02% per year. Between 2009 - 2010, deforestation was 10,287 ha per year or a rate of 0.06%, representing a threefold increase, claimed largely as a result of mining (90%) and road and other navigation infrastructure

The key land degradation impacts of mining activities, identified in the NALDG, include:

- Loss of soil and it's movement into water bodies
- Soil contamination and compaction
- Decrease in water quality, such as sedimentation, discolouration and alteration to the flow of water bodies
- Erosion
- Forest cover loss
- Piling of mine soils with low pH levels; and
- Tailings dumped directly into waterways.

Case Study: Trade-offs between gold and green

Gold mining is becoming an increasingly popular activity in Guyana particularly because the gold prices are high and the country has a wealth of gold deposits. Currently, gold accounts for nearly half of Guyana's total exports in terms of economic value.

There are significant gold deposits in Guyana's pristine rainforests, which are comprised of unique ecosystems and home to unique species, such as the golden tree frog, jaguar and harpy eagle. When one BBC journalist flew over the country, she noted that "the back dams stand out as ugly scars on an otherwise deep green surface". The back dams are mining camps set up for varying lengths of time dependant on how long miners stay mining in the area.

Guyana has the right to increased economic development, as all nations do, but should it come at the cost of damaging Guyana's unique and precious flora and fauna?

Source: *How Guyana gold mining threatens its green future.* Published 26 November 2011, Sarah Grainger, BBC News Latin America & Caribbean. http://www.bbc.co.uk/news/world-latin-america-15852970

Furthermore, when mining and forestry take place in the same region, as is often the case in Guyana (see Map in Unit 6) land degradation is intensified. For example, forests become patchier which in turn, increases the risk of forest fires and biological degradation.

Unit 8: Human Settlement

Objective: *To provide an understanding of the impact of human settlement choices, patterns and practices on land degradation.*

Introduction

Half of the global population inhabit less than 3% of the available land area (excluding Antarctica) however the impact of urban systems on the environment extends way beyond urban boundaries. We are witnessing increased demand by cities for food, fuel, water and other natural resources. The primary areas of concern in terms of land degradation are land use change through urban expansion and suboptimal human settlement patterns and associated issues such as improper solid waste disposal. This is of local concern to us too, the most rapidly growing cities are all located in the tropics

This Unit is broken down into the following impact areas:

- Sub-optimal land conversion patters
- Destruction of mangrove forests; and
- Unsustainable waste disposal practices.

Did you know the earth is becoming brighter and brighter?

Scientists have photographed the lights that can be seen from earth when viewed from space, over a series of years.

Over the last few years, lights have increased both in intensity (i.e. more people are using electricity) and spatial distribution (i.e. people are inhabiting more and more areas).

The Millennium Assessment highlights three processes driving urban change:

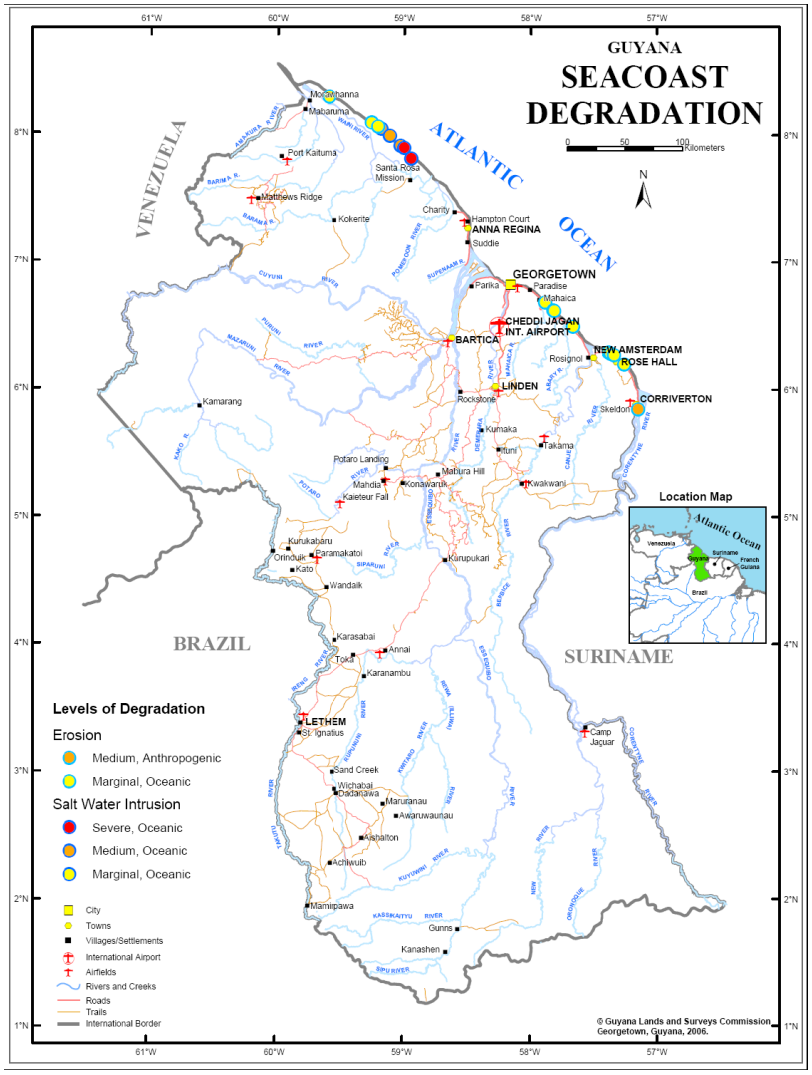
1. Growth in urban population i.e. "urbanization"
2. Growth in built-up areas i.e. "urban growth" and
3. Spreading of urban functions into the urban hinterland i.e. "urban sprawl"

Sub-optimal Land Conversion Patterns

The Millennium Assessment states that it is common, globally, for potential agricultural, or other highly productive land, to get converted to residential land, infrastructure and/or for other amenities. This is an issue in Guyana too. The country's most fertile agricultural land, characterised by rich alluvial soils, is located on the narrow coastal belt. The coastal belt is also where 90% of Guyana's population live, in some cases, in highly concentrated areas. What's more, it is a highly vulnerable area because it lies 1.5 to 3.5 feet below the mean high-water

mark. Refer to the Map below for an overview of the geographic spread of land degradation issues of the coastal belt in Guyana.

Guyana is also experiencing urban sprawl through, according to the NALDG, rural to urban migration. This has lead to loss of the Green Belt and Conservation Reserves along the coastal belt.



Destruction of Mangrove Forests

As per the NALDG, mangrove forests are recognized as:

"Important coastal and riverine ecosystems in Guyana.... They protect the coast through stabilization of the shoreline by minimizing erosion from waves... They are the first line of defence against wave actions and storms."

Mangrove forests are removed for a variety of reasons including the provision of firewood, boat making and land clearing for coastal development. Flooding exacerbation is one example of an impact caused by the removal of mangrove forests. According to the NALDG, flooding in Guyana can cause extensive physical damage in turn creating significant economic loss. This is one good reason why we should protect and maintain one of our natural defences against flooding

- the mangrove forests. Another is the provisioning role mangrove forests play by providing nursery habitat for populations of young fish.

Unsustainable Waste Disposal Practices

Increasing population leads to increased waste generation as more people demand more and more goods and services. Inappropriate disposal of domestic and industrial waste negatively impacts soil, air and water quality through the same mechanisms that have been discussed previously – increased pollution, sedimentation, eutrophication and damage to soil characteristics.

The NALDG noted the following observations when studying Guyana's urban settlement areas:

- **Industrial waste present:** Even though there are relatively low levels of industrial activity in Guyana, waste from detergent, pharmaceutical and plastic industries has been identified as a key soil and water pollutant.
- **Drainage systems were clogged:** Plastic bottles, Styrofoam boxes and plastic bags clogged many drainage systems. This not only leads to pollution but causes a serious issue when flooding occurs as drainage systems can't function properly.
- **Improper household waste disposal systems:** Some settlements in Guyana do not have appropriate waste disposal infrastructure or systems in place. Additionally, when systems or infrastructure were in place, they weren't always being followed or used e.g. waste dumping does not happen solely in official dump-sites but spread to other public areas, vacant lots and river gullies. This increases the spread of pollution which has negative impacts on soil, air, water quality and general aesthetics.

Source: Environmental and Social Assessment of Sea Detailed Design and Tender Assistance Project for the 9th EDF (2008)

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Unit 9: Governance issues

Objective: *To provide an overview of the weak policy and legislative framework in Guyana which indirectly leads to, or exacerbates, land degradation issues.*

Governance issues are more an indirect land degradation driver but are nonetheless significant. Weak legislative and policy frameworks combined with little to no monitoring and enforcement of whether or not individuals or organizations "do the right thing", act as disincentives for people to act in an environmentally responsible manner. "Doing the right thing", such as reclaiming mine sites or following regulation, can be timely or involve additional cost. Some organizations and individuals are unlikely to comply or undergo these activities unless they know they are being monitored and even fined for bad practice.

The key governance issues of concern are:

- **Weak policy environment:** Policies for environmental management (such as SLM) do not always exist and when they do exist, it is rare that they include strict monitoring and enforcement protocols. Additionally, it is rare that policies are based on a "Systems Approach" (which we will discuss further in Part 3).
- **Little or no enforcement:** Low levels of issuing fines for **:** Low levels of issuing fines for inappropriate behaviour and if fines are issued, or bonds are not refunded, the monetary value of these is usually too insignificant to act as a disincentive for unsustainable behaviour.
- **Lack of coordination between Government agencies:** Lack of coordination between Government agencies often leads to mixed messaging going out to the public domain and weak policies not fully supported by all Government agencies.

Local examples of weak environmental enforcement

The NALDG notes

- Prior to 2007 there was **no requirement for forest management plans**, and consequently no insistence on the sustainable management of Guyana's forests
- There is a lack of enforcement of mining and environmental regulation as in part, it is difficult to regulate small itinerant miners
- There is a very low fee charged for the environmental mining bond; the NALDG estimates it's between US$125 – US$500 which is sometimes cheaper to forego than pay for correcting any environmental problems caused

- **Lack of incentives:** There is a general lack of positive incentives aimed at promoting responsible behaviour. What's more, there is a disproportionate over-supply of disincentives.
- **Lack of resources and capacity:** Many government departments, responsible for ensuring environmental health, do not have the people power, budget, appropriate training or enabling systems to effectively carry out their mandate.

Exercise:

Get the class to break up into three groups. Assign one of the following industries to each group: mining, agriculture and forestry.

Get each group to devise a short theatrical skit based on the following scenario:

- Most of the group are employed by their specific industrial sector assigned, there are one or two regulators from the Government and one or two people who live next to the industrial activity site (e.g. mine, forest or farm paddock)
- Each group must depict typical industrial practices and some of the possible environmental impacts
- Show how the regulators and the neighbours are impacted by the industrial activity taking place
- Can you come to a resolution within the group i.e. negotiate a scenario to make everyone happy?

Get each group to perform their skit to the class. Facilitate a discussion around the key issues each skit uncovers or explores.

Unit 10: Natural Phenomena

Objective: *Introduce key natural phenomena that add to or create land degradation with a focus on climate change and its relationship to land degradation.*

Introduction

Naturally occurring events such as floods, hurricanes and droughts and naturally occurring phenomena, such as climate change, have impacts on the land and ecosystem services. Sometimes the impacts of these events and phenomena on the land and ecosystem services are obvious, such as when settlements, crop and livestock paddocks are inundated with flood waters and the town's supply of drinking water immediately becomes polluted. At other times, the impacts are very subtle and harder to identify in terms of their impact on land and ecosystem services. Take for example the changes that can occur slowly, over the period of a few years, where summers become longer and winters become shorter. This shift in climate, through permanent changes to the seasons, has serious ramifications for ecosystem services that provide the right environment to grow food and fibre crops for example. Imagine what could happen if longer summers provided favourable conditions for crop destroying pests and disadvantaged their natural predators.; What impacts would this have on vital pollinating insects? What impacts would this have on supply of water for irrigation? The frightening thing is these are not purely fictional scenarios. Scientific organizations around the world are working on these issues now – quantifying impacts and modelling future scenarios.

One of the key "natural" phenomena impacting the land is climate change. Climate change will be the focus of this unit as it is such a serious issue; the United Nations Secretary General has gone so far as to say it is the major overriding environmental issue of our time as it has implications for economies, food production, societies and security.

Some "natural" factors can be directly linked to anthropogenic phenomena. Take for example, severe weather events. The Intergovernmental Panel on Climate Change (IPCC) predicts these events will increase in frequency and severity as a result of climate change. Climate change, another "natural" phenomenon, has been inextricably linked to anthropogenic increases in greenhouse gas (GHG) emissions by the IPCC.

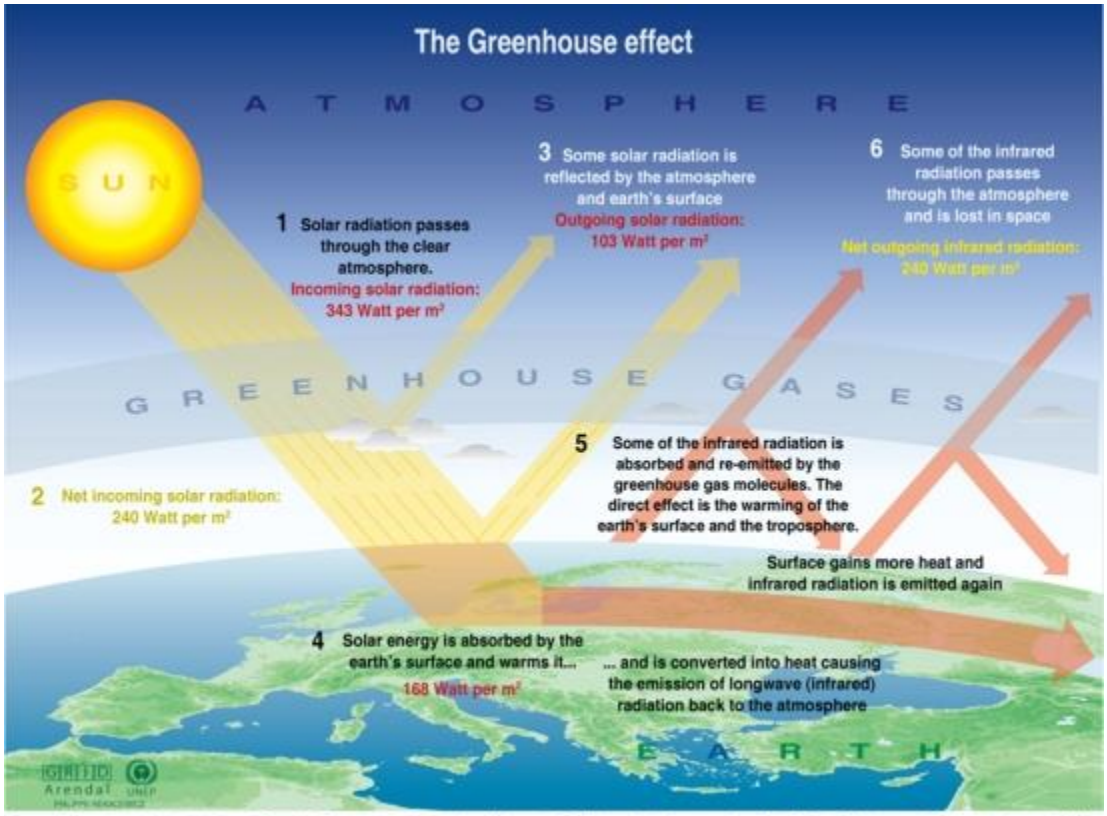
What is Climate Change?

Climate change is the scientific term used to describe long term changes in parameters, which aggregated build a specific "climate". These climatic parameters include mean temperature, mean precipitation, sea level and the recorded historic extremes of these parameters (e.g. maximum evening temperature and minimum winter temperature). Around the globe, we are witnessing changes in climatic parameters leading to, on average, a warming of the globe i.e. "global warming". Changes in climatic parameters are directly linked to increased greenhouse gas emissions caused by human activity (through industrial activity for example).

GHGs help keep the planet warm through "the greenhouse effect" (see diagram below), but when there are too many GHGs "trapped" in Earth's atmosphere, there is potential for irreversible heating of the Earth and permanent changes to climatic parameters and hence, the climate.

The principle GHGs are:

- Carbon dioxide (CO_2)
- Methane (CH_4) which is approximately 21 times more effective at trapping heat than CO_2 and
- Nitrous oxide (N_2O) which is approximately 310 times more effective at trapping heat than CO_2.



Sources: Okanagan university college in Canada, Department of geography, University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996.

As can be inferred from the diagram above, global warming and climate change does not operate on national boundaries – the only boundary climate change has is the atmosphere. It doesn't matter where GHGs are released; they all end up in the atmosphere which is a globally shared ecosystem resource. Additionally, impacts of climate change will not be equally dealt or felt, across the globe, for example, the largest emitting nation may not feel the severest of climate change impacts.

The Intergovernmental Panel on Climate Change (IPCC), in its Forth Assessment Report, states "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level." Evidence of climate change and global warming (as per IPCC):

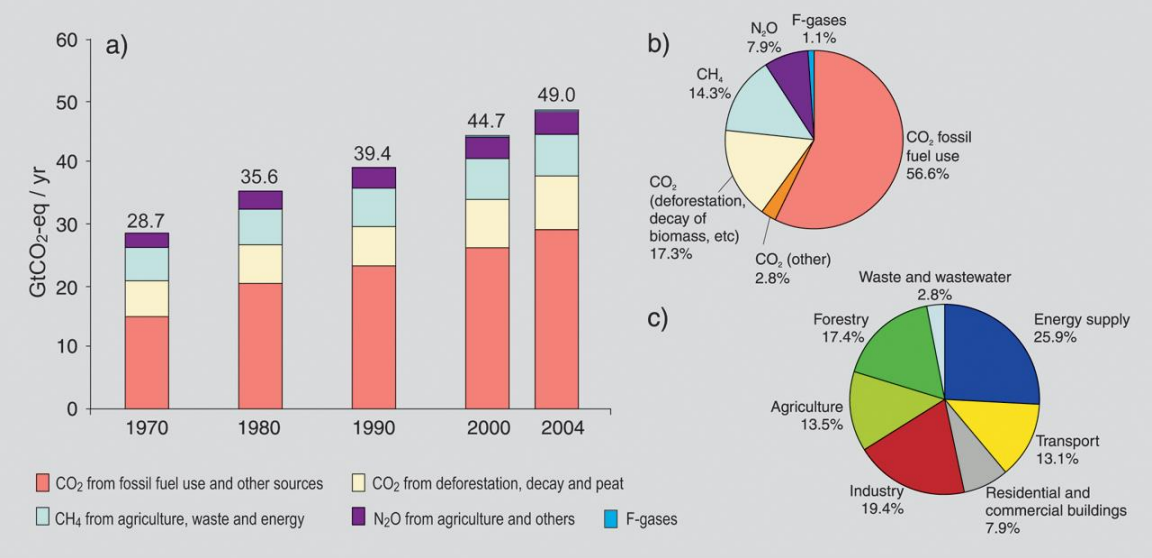
Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature since 1850

- Global average sea level has risen since 1961 at an average rate of 1.8 mm/year and since 1993 at 3.1 mm/year
- Annual average Arctic sea ice has shrunk by 2.7% per decade
- The occurrence of "highly unusual and extreme weather events" in Latin America since 1992 increasing mortality and morbidity in affected areas
- Increase in intense tropical cyclone activity in the North Atlantic since 1970

Flooding in Lethem, Region 9 in 2011

Despite what scientists have been telling us for the last couple of decades about the dangers and risks of continuing to pollute the atmosphere with GHGs, we continue to release GHGs into the atmosphere. According to the IPCC, between 1970 and 2004, GHG emissions grew by 70% and they are continuing to grow.

One of the largest sources of GHG emissions is the combustion of fossil fuels as is evident from the diagram below. Fossil fuels store the carbon that was present as a living organism many millions of years ago.



Anthropogenic GHG emissions (IPCC, Fourth Assessment Report, Climate Change 2007, Chapter 2, Figure 2.1)

How does Climate Change add to Land Degradation issues?

Science tells us that climate change will have direct and indirect impacts such as:

- **Direct impacts:** Changes in temperature, precipitation, extreme climatic events and more.
- **Indirect impacts:** Changes to the intensity and frequency of disturbances such as flooding, storms and wildfires.

Scientists cannot predict the exact impacts of climate change – it is a lot harder than forecasting the weather! There are many many variables that have to be considered and many of these variables do not behave in a predictable linear manner. What scientists and policy makers do know is that it pays to be cautious when the health of humans and the environment is at risk (see the Precautionary Principle).

Impacts linked to climate change have already been observed in Guyana including an increase in the annual temperature of Georgetown by 1ºC within the last century and national annual rainfall from 1960 onwards being, for the most part, below the long term average. Projected impacts of climate change include a 40% decrease in the global fish catch potential in the tropics (and an increase of 30-70% global fish catch potential in high latitude regions).

The impacts to land and ecosystem services will vary, according to the degree of anthropogenic influence already present. As an example, the effects of climate change will likely be more pronounced and severe on land that has been degraded by heavy industrial activity such as deforestation, mining or intense agricultural practices than land that has not been subject to the same level of activity.

There is a principle called **"The Precautionary Principle"**, sometimes called the precautionary approach. It states that if the occurrence of an event or action could cause harm to people and/or the environment, the event or action should not be undertaken. In other words, harmful outcomes of events/actions don't have to be proven to have 100% probability of occurring, before people take action against them. The approach promotes preventative precautionary action.

In the case of climate change, we know certain unpleasant impacts are highly likely to unfold (e.g. increase in severe storms, sea level rise and increase of insect-borne diseases) but can't 100% prove that they will unfold so, if we were to follow the precautionary principle, we would start to dramatically decrease activities which result in greenhouse gas emissions.

Did you know some regions/nations have ingrained this principle into their law!? The European Union has made the application of the precautionary principle a statutory requirement.

Furthermore, many of the detrimental environmental impacts climate change is forecast to bring are forecast to happen anyway, regardless of climate change. This means, climate change has the ability to amplify already occurring environmental events and phenomena.

Furthermore, many of the detrimental environmental impacts climate change is forecast to bring are forecast to happen anyway, regardless of climate change. This means, climate change has the ability to amplify already occurring environmental events and phenomena.

Activity:

Set the class a homework assignment to be completed in no more than a half hour. Ask the class to each answer the following questions encouraging students to research further if they have the time and resources:.

List four impacts you think a warming climate will have on (a) your neighbourhood, (b) your country and (c) the globe?

- What category does each of the impacts fall under, the choices are: People, Economies or Environment.
- If you don't already have an impact under each category, list one.
- Which of these impacts you have listed will make the land degradation issue worse?

Facilitate a discussion on the answers students provided to these questions and recreation.

Climate change is happening now, as evidenced through IPCC findings. We can't change that fact but we have the ability to decrease the severity of impacts through decreasing GHG emissions locally, nationally and globally (i.e. mitigation), implementing forward-looking adaption strategies to address "locked-in" climate change (i.e. climate change that will happen regardless of whether we stopped emitting all GHGs today) and its impacts. For more information and ideas on how we can address climate change, see Part 3.

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PART THREE

Part Three:
Conservation and Restoration through Sustainable Land Management

Teacher's Resource Guide, Part Three

Knowledge and skill outcomes

KNOWLEDGE, understanding of:

- Sustainable Land Management as a paradigm, principle and approach which positively impacts economies, ecosystems and people; both locally and globally.
- How SLM will help conserve key industrial sectors of Guyana such as agriculture, mining and forestry.
- How SLM can help mitigate against, and adapt for, global warming and climate change.
- The importance of scientific and indigenous knowledge to SLM.

SKILLS, development of:

- Critical thinking and problem solving
- Creative thinking
- Public speaking
- Research skills

Related syllabus sections

- Biology Syllabus
    - Section E, Objective 5.3
- Agricultural Science Syllabus
    - Section A, Objective 3.1
    - Section A, Objective 3.2
    - Section B, Objective 1.15
- Geography Syllabus
    - Section IV, Objective 10

Introduction

In 2011, our planet's population reached seven billion people – and yet we only have one planet to provide the necessary food, energy and water to support this expanding demographic. As discussed in Part 2 of the Guide, threats to food, energy and water security include land degradation, resource scarcity, a decreasing reserve of cheap fossil fuels and poverty. Sustainable Land Management (SLM) is part of the solution to overcome these challenges and help achieve security, prosperity and posterity.

SLM is designed to aid in the transition to a sustainable future by simultaneously promoting the three pillars of sustainability – prosperous local economies, community health and well being and environmental integrity It is an approach to land management which "[is]... the combination of technologies, policies and activities aimed at integrating socio-economic principles with environmental concerns so as to simultaneously maintain or enhance production, reduce the level of production risk, protect the potential of natural resources and prevent soil and water degradation, be economically viable and be sociably acceptable." **(**TerrAfrica's definition).

Much of SLM literature focuses on agriculture, water efficiency and soil protection. It also focuses on land use management in the context of forestry, mineral extraction and human settlement planning.

Part 3 of the Guide discusses SLM in the context of the following topics:

- Agriculture
- Forestry
- Mining
- Urban settlements
- Governance
- Climate change, and
- Scientific and indigenous knowledge.

Other topics that teachers may want to explore over and above the content outlined in this Guide include:

- Research and technology development
- SLM capacity building and knowledge exchange, and
- Sustainable levels of consumption.

These are all important topics that form an important part of SLM.

Unit 11: Sustainable Land Management Approach to Agriculture

Objective: *To provide an overview of SLM practices in agriculture.*

Sustainable land management includes the practice of food production using principles of ecology, the use of traditional systems and local and integrated plant and animal practices. Done well, SLM will increase agriculture production and help achieve food security and curb the loss of soil, increase water efficiency and biodiversity.

SLM practices have the following goals:

- Maintenance of ground cover
- Restoration (or conservation) of soil organic matter and soil fertility
- Conservation and efficient management of water
- Improved management of plants
- Improved livestock management, and
- Control of pests and diseases.

This Unit outlines:

- Overview of SLM practices
- Practices specific to conserving soil fertility, and
- Practices specific to using water efficiently and effectively.

Overview of SLM Agricultural Practices

Based on extensive research, TerrAfrica categorises tropical SLM agricultural practices into four categories. Although these practices originated in Africa, the principles and approaches can be applied to other tropical countries as land degradation challenges can be very similar. Each of these is described below:

- **Conservation agriculture:** this involves methods which minimize soil disturbance, maximize permanent soil cover and rotate crops. For example, no-till or reduced tillage approaches, directly drilling crop seeds into cover crops or mulch, and managing crop cover for weed control.
- **Agroforestry:** this involves methods which integrate trees and agricultural crops or animals on the same unit of land. This can take the form of spatial or temporal integration. Practices include alley cropping, intercropping, contour farming, multi-storey cropping, multiple cropping and more.
- **Rainwater harvesting**: this involves collecting and storing rainwater for agricultural use. It usually incorporates: (a) a catchment zone where run-off is collected, (b) system to direct run-off and (c) a storage area.
- **Improved grazing land management**: this involves regulating stocking rates according to the productive capacity and availability of vegetation resources and controlling grazing by adjusting stocking rates and allowing resting period.

It should be noted that SLM "best practices" are often traditional local practices that have developed or grown up over long periods of time. Efforts are underway to reintroduce these practices where they have been lost, or put in place support to retain these where they still exist.

Agricultural Lands near the Essequibo River

Table 1: Benefits and constraints associated with agricultural SLM practices

Practice	Benefits	Constraints
Conservation agriculture	Increased crop yields (realized 4-5 years of this practice), yield reliability and water efficiency. Reduced labour requirements, energy use, agrochemical contamination, greenhouse gas emissions, run-off and soil erosion.	Establishment costs (varies widely) to purchase machinery (e.g. no-till seeders) and tools. Competition for residues (i.e. animal versus soil cover). For small scale farms, labour requirements initially can be higher due to weeding.
Agroforestry	Diversification of food and income sources, improved land productivity, halting or reversing land degradation. These are achieved through keeping permanent soil cover, improving soil quality, increasing infiltration, enhancing fertility and biological activity.	Managing competition between products, labour and time intensive.
Rainwater harvesting	Reduces risk of crop failure and problems associated with water shortages, reduced off-site damage including flooding and erosion.	Establishment costs and high initial and ongoing maintenance labour requirements. High level of technical knowledge required. Reduced amount of land especially for small farms.
Improved grazing land management	Increased carbon sequestration and decreases land degradation (as vegetation cover increases). The land can become more productive.	Investment costs can be high and survival rate of shrubs and trees can be low. Lack of land use policy, land tenure issues and weak formal/informal monitoring and enforcement can be challenging.

Conserving and Enhancing Soil Quality

SLM agricultural practices aim to protect, conserve, and ideally enhance the quality of soil in terms of chemical, physical and biological characteristics. This will support ecosystem services to function properly, reduce pollution in the air and waterways and facilitate the growth of healthier food and fibre crops. The following practices have been identified as especially beneficial to improving soil quality:

- **Targeted use of farm inputs**: this refers to more efficient and smarter use of water and application of agricultural chemicals to ensure long term sustainability and health of soil. In terms of best practice, harsh chemicals are substituted for less harsh chemicals or used sparingly as a last resort. Water use is such that soil quality is optimized through avoidance of erosion and un-planned salt-water flooding.
- **Recycle organic nutrients:** some nutrients found in soil are transferred to plants during the plant growth cycle; one way to recycle these nutrients is to leave crop/plant residues on soil after harvests. If these residues are fed to livestock, ideally livestock are kept in the same field or their manure is transferred to the harvested field. The application of compost to the field is another method.
- **Reducing bare soil exposure:** this can be achieved through the maintenance of plant cover or through the application of mulch. It helps keeps moisture in the soil through reduced evaporation, avoids the chance of soil being blown away into the air and waterways and promotes biological activity in the soil.
- **Select and use adapted and efficient species:** some plant species fix nitrogen from the atmosphere and transfer this valuable mineral back to the soil. Other species develop large amounts of residue which can be kept in the field or have deep root systems helpful for loosening compact soil and transferring nutrients and promoting healthy biological activity in the soil.

Case Study: Cauca Valley, Colombia

Cauca Valley's agricultural producers pay fees to communities who inhabit the areas upland/upstream, to compensate these communities for implementing SLM activities. Cauca Valley producers know that SLM initiatives conducted upstream will benefit their production downstream.

Activities implemented include: soil conservation, reforestation and maintenance of riparian zone buffers (zones to protect waterways). These activities help support the healthy functioning of ecosystem services and keep waterways clean of sedimentation and chemical pollution.

Source: The World Bank 2006

Water and food relationships:

- Number of gallons of water to produce one pound of beef: 1,857 gallons
- Fraction of the world's population living in countries where water tables are falling: Half
- Estimated year when conventional sources of seafood will all suffer collapsed populations: 2050
- The true cost of a hamburger, charging all the externalized costs (water, energy, land etc.) to the consumer: $200

Water needs for meat production

Water requirements to produce 1 kg of meat	
Chicken	3,500 – 5,700 kg of wataer/kg of meat
Pork	4,000 – 6,000 kg of water/kg of meat
Beef	15,000 – 50,000 of water /kg of meat

Increasing Water Use Efficiency

Food production takes water, and lots of it! As The World Bank states in their report

"Sustainable Land Management: Challenges, Opportunities and Trade-offs", the potential to increase water efficiency and produce more food per unit of water is significant. Reading between the lines, this means current water usage in many nations across the globe is wasteful and there is vast opportunity for improvement. The World Bank provides the following SLM measures to improve water efficiency:

Cattle grazing in a pasture

- **Clarify water rights and land tenure:** improve water management in both irrigated and rain-fed agricultural practice by clarifying, developing or securing clear water use rights and land tenure agreements.

- **Improve the soil quality:** improve the soil quality of farmed areas to reduce pollution of waterways through, for example, artificially chemical pollution and sedimentation through erosion. Improving soil quality can be done through improving biological, chemical and physical soil properties.
- **Employ rain water capture:** harvesting rainwater will help decrease the pressure of dry periods and be a useful source for supplementing (or even being the only source of) irrigation.
- **Protection of vegetation in riparian zones:** riparian zones are the areas directly adjoining water bodies such as streams and lake shores. Reducing erosion in this area, by keeping grazing animals out and maintaining vegetation cover, is important to keep water bodies sedimentation levels low.
- **Set up effective private or public support:** marketing of new programs and policies plus provision of affordable credit for technology and storage infrastructure.

Oil price increases are raising the price of food:

"Distance suddenly costs money, and lots of it… Your neighbors and your neighborhood are about to get a lot more important in the smaller world of the none-too-distant future."

— Jeff Rubin

Exercise:

- Divide the class up into small groups of between 2-4 students.
- Assign each group a different agricultural system e.g. dairy farm and sugar cane plantation.
- Get each group to brainstorm where water is needed in the system they were allocated e.g. water is needed to nourish farm animals and/or crops.
- Get the groups to list the sources and locations of where water enters the system.
- Get each group to brainstorm and record how water-use could be improved and made more efficient. Guide the groups with the following requests and questions:
- How could water be recycled in the system, or used in the system and then recycled for another use outside of the system?
- Is it possible to substitute town supplied water with rain water captured? If so, how?

Unit 12: Sustaining Productive Forests

Objective: *To introduce sustainable forest management.*

Actions to stop and reverse land degradation associated with forest loss are a priority in Guyana and around the world. Forests are important for maintaining/ growing carbon dioxide sinks (or "carbon sink"); sustaining the abundance of natural forest resources such as timber and medicinal plants; protecting water supply and; providing habitat for species including umans.

The United Nation's definition of Sustainable Forest Management (SFM) reads:

"Sustainable forest management ...aims to maintain and enhance the economic, social and environmental value of all types of forests, for the benefit of present and future generations. It is characterized by seven elements, including: (i) extent of forest resources; (ii) forest biological diversity; (iii) forest health and vitality; (iv) productive functions of forest resources; (v) protective functions of forest resources; (vi) socio-economic functions of forests; and (vii) legal, policy and institutional framework."

Guyana is blessed with a rich variety of tropical forests. This Unit provides examples of SLM activities that can be undertaken in all of Guyana's forests from coastal mangrove forests to dense rainforests.

More than **1.6 billion people depend** on, to varying degrees, **forests** for their livelihoods!

Forest products provide include timber, fuel-wood, medicine, plants and food.

Students and Teachers from Stewartville Secondary School on a Nature Tour at the Yarowkabra Training Centre

Annual Green-walk Event coordinated by the Environmental Protection Agency

Case Study: Consider the Importance of Wetlands and the Savannah Catchment Area

Wetland ecosystems (including lakes, rivers, marshes, and coastal regions to a depth of 6 meters at low tide) deliver a wide range of ecosystem services that contribute to human well-being, such as fish, water supply, water purification, climate regulation, flood regulation, coastal protection, recreational opportunities, and, increasingly, tourism (RAMSAR, 1971). At the same time, the degradation and loss of wetlands is more rapid than that of other ecosystems (Millennium Ecosystem Assessment, 2005). Indirect drivers of degradation and loss have been population growth and economic development. The primary direct drivers of degradation and loss include infrastructure development, land conversion, water withdrawal, eutrophication and pollution, overharvesting and overexploitation, and the introduction of invasive alien species.

The knock on health threats of these changes in wetland ecosystems include the reduction in fish supply, increased incidence of vector-borne and waterborne diseases, degradation of water supply and quality, increased risk of flooding, excessive nutrient loading in waterbodies and decrease in potential economic income. Growing pressures from multiple direct drivers increase the likelihood of potentially abrupt changes in wetland ecosystems, which can be large in magnitude and difficult, expensive, or impossible to reverse.

The North Rupununi District in south-west Guyana is a mix of savanna, forest and wetland ecosystems. The region straddles the watershed divide between the Amazonian basin and the Essequibo River catchment, the largest drainage basin of the Guiana Shield. The area is dominated by three large rivers: the Rupununi, the Takatu, and its tributary, the Ireng. In this area the three rivers pass within approximately 30 km of each other, separated by savannah, criss-crossed by a network of small rivers, creeks and lakes. The Rupununi River drains the central and eastern parts of the savannas, and flows east into the Essequibo. The Takutu and Ireng Rivers drain the western portion of the savannas and flow west into what is eventually the Amazon via the Rio Branco and Rio Negro.

The North Rupununi is made up of a range of rainforest, savanna and wetland ecosystems which in turn provide a unique and diverse selection of habitats for a rich biodiversity. It has been argued that the seasonal water bridge between the Amazonian and Guiana Shield basins represent a link for species and biodiversity, and is thus a key site for species migration, as well as providing an abundance of food, breeding grounds and diverse habitats. Fishes, turtles and many native birds feed, breed and live in the wetlands all year round. At the same time, many species of migratory birds rely on the wetlands as feeding and breeding grounds. Flooding of these wetlands provides the opportunity of migration for fishes and other species of fauna that would have been otherwise isolated for a time of the year. Similarly, plant species are assisted by seasonal flooding by permitting seed dispersal.

Source:- Th e North Rupununi Adaptive Management Process (NRAMP), 2008 prepared by Darwin Initiative Guyana Partnership with Wildfowl & Wetlands Trust, Royal Holloway University of London, Th e Open University, Iwokrama International Centre for Rain Forest, Conservation and Development Environmental Protection Agency, North Rupununi District Development Board, University of Guyana

Establish and Implement Forest Management Plans

In Guyana, industrial forest users are required to develop and submit Forest Management Plans (FMPs). Guyana's Forestry Commission has the responsibility of conducting field visits to monitor compliance with FMPs and initiating Environmental Impact Assessments. The diagram below shows the feeds into and products of FMPs.

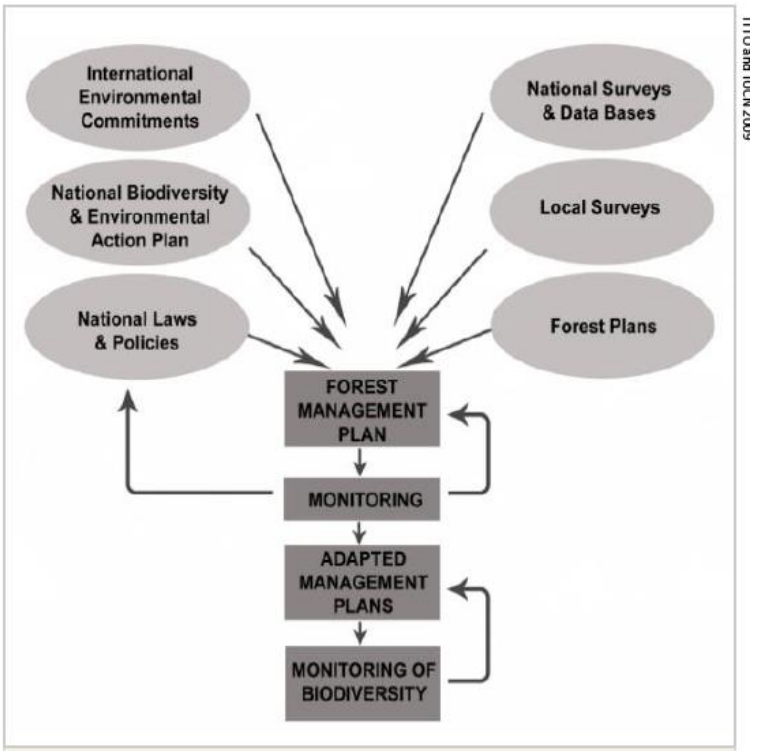


Figure 2: *Sequence of actions to achieve biodiversity conservation and sustainable use in production forests.*

Secretariat of the Convention on Biological Diversity (2009)

To build a robust sustainable forest management plan, the following key points have been suggested by the Secretariat to the Convention on Biological Diversity and the National Assessment of Land Degradation in Guyana (NALDG):

- **Identify and clearly outline biodiversity conservation objectives**: anticipate actual, potential and emerging threats to biodiversity and build-in contingency plans.
- **Plan at the landscape scale:** planning at this larger scale can help to identify and then minimize impact in terms of continuity of mature tropical forests and populations of valuable species and seed trees.
- **Develop forest zones**: clearly identify forest areas for production, conversion and protection/conservation. Pay attention to incorporating a diverse range of ecosystems in areas chosen for conservation. (In Guyana, forest concession holders are required to set aside a block in each concession area

which is representative of all forest types to help protect biodiversity.)

- **Implement reduced impact activities**: when developing harvesting plans, avoid unique biodiversity areas where possible and implement reduced impact logging techniques wherever possible especially in and around special biodiversity features.

- **Build-in regular stakeholder engagement sessions:** there is a lot to learn about forest conservation and production from local stakeholders (stakeholders involved at the landscape level). Building-in meetings with stakeholders (such as local village people, Iwokrama, The World Wildlife Fund and the International Centre for Rainforest Conservation), especially at the initial stages of new forestry activities can be highly beneficial to forestry's contribution to local economies, local environments and local people which is the sustainable solution in the long term.

In many regions and nations, strong forest management plans have been developed but often they are neglected by forestry organizations and local groups; enforcement levels are low and detrimental actions are not punished. These realities will undermine sustainable forest management. Some examples of how to rectify the occurrence of these situations include: introducing disincentives for unfavourable behaviour and incentives for positive behaviour; introducing stronger enforcement and more severe penalties and; strengthening ties between Government Departments to better support established frameworks.

Incentivise the Conservation and Sustainable Management of Forests

In many situations "money talks"; this sentiment has driven the development of programs that financially (or otherwise) reward regions and nations for conserving or sustainably managing healthy forests and their provision of ecosystem services. The United Nations' (UN) Reducing Emissions from Deforestation and Forest Degradation (REDD) program is one such program which, in its simplest form, is aimed at providing financial incentives for developing countries to conserve and maintain sustainable forests in order to capture and store carbon dioxide. It just so happens that many developing countries are naturally endowed with an abundance of unique and productive forests, many of which today are still "intact". The program facilitates the flow of funds from developed to developing countries. The REDD+ program is similar but goes beyond REDD by recognising initiatives of forest conservation, sustainable management of forests and enhancement of forest carbon stocks.

Case Study: REDD+ in Guyana

Guyana has a relatively low deforestation rate by global standards and is in the running to be financially rewarded to keep these rates low!!
Guyana signed a pioneering deal with the nation of Norway with performance based financing of up to US$250 million available over 5 years. Under the terms of this agreement Guyana will be paid to preserve its trees, and so cut carbon dioxide emissions from deforestation and degradation. A deforestation rate baseline has been set and each year rates will be measured and assured to assess eligibility to receive financing, paid to the Guyana REDD+ Investment Fund.

The money earned through REDD+ will be used to implement programs and policies under Guyana's Low Carbon Development Strategy such as tightening environmental enforcement in the mining sector and improving infrastructure.

Source: ICMM (2011)

It's important to note that the REDD program is not without criticism. The latest criticisms follow the recent climate change negotiations which took place in December 2011 in Durban, South Africa where REDD was discussed. The World Wildlife Fund (WWF) published an article saying that progress (or lack of) on the REDD program was so insignificant it was disappointing and the program's objectives had been significantly weakened. WWF warns that if REDD program safeguards aren't well established, people could lose access to forests that they rely on for their livelihood and the interests of the powerful (and not necessarily local) groups could rule.

Follow Existing Forest Certification Standards

Recognizing that consumer demand for sustainably certified products is on the rise in many industries, early adopters are harnessing environmental best practice to create differentiated products and market advantage. This is true in the forestry sector, and such emergent market preferences are creating growing demand for sustainability harvested timber and forest products. Commercial logging enterprises common in Guyana can differentiate their product by managing and harvesting forest reserve stock sustainably.

Certification standards have developed in response to the need to provide assurance over claims that products are produced sustainably. There are a number of forest certification standards specific to forestry. Forest Certification Standards typically require that forest management practices follow existing law and follow one or more of the following requirements:

- Protection of biodiversity (including protecting species habitat, implementing sustainable harvest levels and prompt regeneration timelines and protecting water quality)
- Multi-stakeholder involvement
- Complaints and appeals processes; and
- Conduct of a third party audit to assess whether or not the Standard has been followed.

Forest certification standards are also increasingly considering the social benefits created through the industry.

Case Study: Recovery of the Arapaima Fish

The Arapaima fish (*Arapaima gigas*) is the largest scaled freshwater fish in the world, it can be found in the freshwater bodies of Brazil and Guyana. It is also a protected species as its population was at serious threat a few years ago.

The good news is the species was recognized as being in decline before it was too late. A management plan for its conservation was developed and the species population seems to be increasing. Regular monitoring takes place and strict fishing and harvesting rules exist. Two really important rules are that adult Arapaimas are harvested only when they are not reproducing and that the number of Arapaimas harvested each year is equal to the fishing quota which is set at a sustainable level (meaning the fish population should be stable or grow, not decrease).

It is important to continue monitoring population numbers and enforcing harvesting rules to make sure this species survives for many years into the future.

Further information:

Iwokrama International Centre for Rainforest Conservation and Development http://www.iwokrama.org/wp/

Arapaima Management Plan, approved by the Government of Guyana as part of the Fisheries Ac

Local scale Arapaima Fish Management in the North Rupuni, Guyana: lessons learned

http://www.coastalcura.ca/documents/JafferallyHaynesPosterSecured.pdf

Unit 13: Sustainable Mining Practices

Objective: *To provide an understanding of land reclamation and other practices which minimize the environmental impacts of mining and /or create net positive environmental impacts.*

Global biodiversity is down 30 percent since 1979. This decline is due mostly to habitat loss in tropical regions where biodiversity has declined by 60 percent. The loss of biodiversity and habitat undermines ecosystem services on which we depend. Mining operations around the globe, whether in tropics or the far north must be committed to integrated land use planning and biodiversity protection and enhancement. With proper planning, the mining industry can take measures to minimize and prevent biodiversity loss and habitat disruption impacts throughout the life of a mine.

Historically, the majority of Guyana's mining activities have been small-scale gold and diamond mining operations. As the world's metals and mineral resources become increasingly scarce, Guyana's deposits are becoming increasingly valuable and sought after. Currently, a number of international companies are undertaking exploratory activities in Guyana in the search for metals and minerals.

This Unit outlines SLM mining practices for each stage of the mine life cycle namely: exploration, construction, operation and closure. The focus is on larger scale mining operations, however, lessons are relevant to operations at different scales.

SLM during Exploration

Recently, Guyana enforced mandatory systematic exploration by medium scale miners before allowing forest clearance and excavation to take place. This has not always been the case, wherein exploration before excavating had not been routinely practiced for smaller operations. Proper exploration techniques ensure minerals and metals are actually available for mining before disrupting ecosystems and habitats. Exploration techniques themselves vary in terms of their impact on the environment. There are technologies available such as remote sensing and satellite imagery which can reduce the need for invasive techniques but can be prohibitively costly. However, generally speaking exploration has a minimal footprint as it involves surveys, and small scale sampling and drilling.

During exploration there is a focus on minimizing impact. For example, using existing roads where possible, as opposed to building new roads helps reduce environmental impacts. The International Council on Mining & Metals (ICMM) reports a piece of research which shows that the impact of new roads on deforestation is greatest when new roads create access to previously inaccessible areas. If roads are built within existing infrastructure, the impacts on deforestation are reported to be much smaller.

During the exploration phase, early engagement of local stakeholders as well as investment in local training is considered good practice as this practice will set-up a project well, right from the beginning. Although social investments are not necessarily directly related to sustainable land use planning, there may be ways in which to involve local people in early studies and potentially gain more insight into local environmental sustainability issues and practices.

Employing and engaging local people at all stages of the mining life cycle is a good way to ensure:

- Local knowledge is shared with respect to environmental, economic and social local issues and opportunities
- Fairness in terms of reducing exploitation of local people, places, resources and the workforce
- Boosts to the local economy whose resources are being minded.

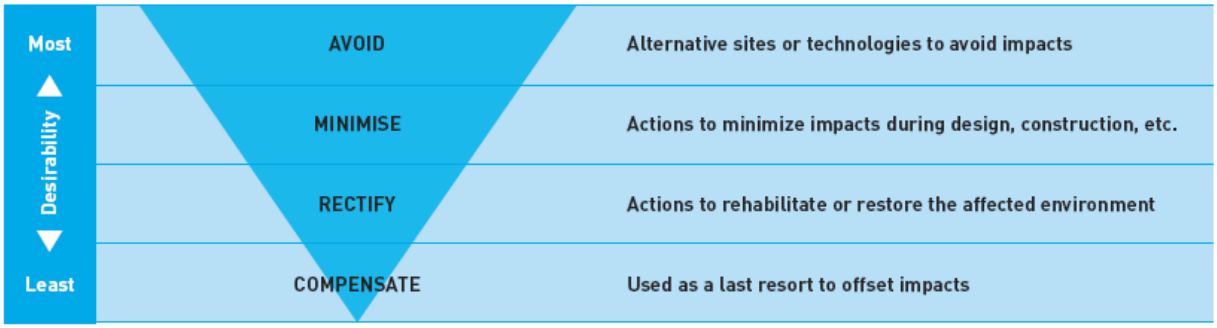
SLM Planning during the Construction Phase

Building a mine involves using and disturbing land and these activities will have an impact on the natural environment. In the case of larger operations, ensuring ecologically relevant science and knowledge guide infrastructure design and construction can help to alleviate against negative and downstream direct land-use impacts and biodiversity issues.

The environmental feasibility study prepared prior to construction will identify sensitive ecosystems and species, bio-diversity hot spots, and important areas for development and regeneration of eco-system services such as key water-sheds. This information combined with relevant science can form the basis of an eco-systems approach to planning. The foot-print of a greenfield operation is not large, however the total operational footprint including roads, buildings, tailings ponds, pipelines and power transmission lines is significant. Roads in particular pose a challenge as they can open up the area which has been known to lead to extra forestry activities, hunting, additional mining, agriculture and human settlement. In many parts of the world, operations are required to install security at entry points to their roads in order to limit unwanted activity.

As an example, British Columbian mining operations, located in grizzly bear habitat, have employed scientists to monitor and model grizzly bear ecology and habitat use to understand how the bear responds to mining activities. In this way the needs of the grizzly bear can be integrated into mine plans. In another instance, scientific knowledge of caribou migration and predator behaviour is used to inform infrastructure planning including trans-mission corridors.

The ICMM has published a hierarchy of biodiversity mitigation measures developed by Rio Tinto; it is shown on the following page. It highlights steps to go through in the decision making process. As can be seen, avoiding significant impacts is the most desirable practice but if significant impacts have to be made, it is important to, at the very least, compensate for these impacts. The chart was developed in relation to mitigating biodiversity but the general principles can be applied to other sustainability concerns.



ICMM (2011), developed by Rio Tinto, 2004.

Each mining method comes with its own set of unique issues, impacts and SLM practices and strategies. This means that the choice of mining method is an important decision providing options exist.

In Guyana and in the case of smaller operations, through the REDD+ program, support and guidance is given to the mining industry on the application of new less environmentally destructive technologies and practices as well as helping to clarify land-use issues related to over-lapping forestry and mining concessions to reduce the tension between the sectors and threats to the forest.

SLM during Operations

The operational phase of a mine's life cycle typically takes place over long periods of time. Land-use impacts during this phase include the management of mining activity waste (and environmental impacts) such as tailings ponds. Considering the reclamation process at this part of the life cycle is important to ensure tailing ponds are located optimally for reclamation activities and locations facilitate effective and efficient management. Progressive expansion of the mine site constitutes one of the main SLM challenges during this phase as further construction decisions have to be made. Progressive reclamation of land during operations is considered good practice.

Artisanal mining practices which use mercury can be improved through recycling of mercury by creation of a closed loop systems. Alternatively mercury substitutes, such as chemicals which perform the same function of separating gold from rock, can be used. Decreasing mercury use will lead to improved health of the mining workers.

Reclamation is the word used to describe the process of undertaking activities to turn old mine sites into productive areas again such as forests or crop lands. Reclamation takes place during the mine closure life cycle period

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SLM during Mine Closure

Planning and executing mine closure activities present an opportunity to convert brownfield sites into productive healthy ecosystems or to other uses depending on where they are located and what is appropriate. There are examples of tailings dams being converted into productive fish bearing lakes. These lakes also provide nesting and feeding areas for birds. In other instances, reclaimed land is specifically designed to create ideal habitat for rare and endangered species. In yet another instance, the site is converted to fuel bearing crops to be used in the production of biofuel.

Closure activities may include rehabilitation, re-vegetation and reforestation. Closure activities can lead to a net carbon gain through the planting (and carbon sequestration) of native vegetation that didn't exist during the exploration phase.

Biodiversity rehabilitation refers to the practice of transforming the mine to post closure land uses that maximize benefits to biodiversity.

Biodiversity enhancement refers to measures that 'go above and beyond' to enhance or improve biodiversity overall and that are not necessarily responses to direct or indirect impacts of mining. For example, when Vale's Corrego do Meio mine in Brazil was closed in 2005, a Centre for Biodiversity Research and Conservation was created at the site.

Re-vegetation is a reclamation activity of planting a variety of plant species in an area with little to no vegetation; it is a powerful SLM tool.

Benefits of **re-vegetation** include

- Decreasing erosion
- Increasing water infiltration in the soil
- Increasing biological activity both on the surface through attracting insects and animals
- Increasing soil fertility through plant processes taking place at the roots and the application of animal manure
- Introducing economically productive crops or pastures for sustainable animal grazing

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Post-closure management and monitoring is an important aspect of the mining life cycle with the aim to ensure any indirect impacts are addressed in a timely manner.

[Type a quote from the document or the summary of an interesting point. You can position the text box anywhere in the document. Use the Text Box Tools tab to change the formatting of the pull quote text box.]

Case Study: Re-vegetating Kara Kara, East Montgomery and Dorabece

The Kara Kara, East Montgomery and Dorabase are all mined-out areas situated in the Linden-Soesdyke area of Guyana. The areas were characterised by large, stark areas with piles of waste from the mining process. These areas were chosen for a re-vegetation project which took place over 5 years.

Soil cover was established to prevent erosion and increase water infiltration. Grass was planted to help initial slope stabilization followed by the planting of pastures, fruit orchards and trees. Plant species were chosen based on the ability to either provide income through eventual harvesting or feed small animals and arrest erosion of the area. Planting was an important part of helping to improve soil quality also.

Results after 18 months show that planted species were doing well, there was reduced erosion on site and soil quality had improved. Opportunities for improvement included fencing the project area to protect the grass and trees form grazing cattle.

Mining reclamation through replanting

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Case Study: Gold mining closure activities, Ghana, West Africa

Gold mining in Ghana, West Africa is mainly conducted in the tropical rain forest in the west of the country. Although mining has been carried out in one form or another for over 100 years, community development around the Golden Star properties is very limited and most of the community stakeholders have had poor educational opportunities and are subsistence farmers. Mine closure planning has prioritized the economic development goals of the local community. Golden Star's closure plans focus on converting rehabilitated mine lands to palm oil production and subsistence farm crops providing both income and food supply to the local community.

Gold Mining Activity in Region 1

Unit 14: Sustainable Human Settlements

Objective: *To provide an understanding of SLM interventions in the context of human settlements.*

Sustainable human settlements require that we pay attention to a number of factors including rehabilitating and maximizing the ecological health and potential of land in the context of human settlements. Land should be assessed in terms of its best use. The more land has been degraded by human activity, the greater its need for restoration and the greater its potential for development (typically a brown field). This includes degraded farm land where the soil has been 'mined out'. Wilderness and greenfield sites should not be built on, or at a minimum, be subject to limited growth.

In response to housing demands, Guyana's urban pockets continue to grow, particularly in Georgetown and Region 4. By implementing SLM principles and practices in the context of urban planning, Guyana has the opportunity to design human settlements that are characterized by healthy, and productive social and environmental systems.

SLM principles in the context of urban development can include:

Forward planning: plan for access to critical non-renewable (for example, sand and gravel) and renewable resources (for example, a local biofuel supply) sufficient to maintain urban systems.

Appropriate land use: land uses are matched to quality of land and soil in the region optimizing best use.

Resilience planning: land use is organized in ways that minimize risk associated with natural disasters.

Regenerative: contaminated sites are identified and remediated to support industrial or other use; native vegetation is re-established, rural –urban corridors are established for native flora and fauna.

Multi-facetted: land serves multiple purposes and is arranged to maximize efficient use of the region's infrastructure.

This Unit provides examples of SLM interventions in the urban context and is not exhaustive, it covers:

- Creating self-reliant communities
- Designing settlements, infrastructure and households sustainably, and
- Securing land tenure and property rights.

Creating Self-Reliant Communities

Organized land patterns that provide people with space to grow and harvest their own food can help to alleviate poverty, enhance community ties, settlement aesthetics and human health. The space provision does not necessarily have to be within an individual property but could consist of a series of spaces for community/market/kitchen gardens ("community gardens") that community members have access to through allocation of plots or other land entitlement/sharing systems. The benefit of larger scale community gardens is that a wider variety of plants can be grown and productive animals can be kept. In these systems, gardeners know even though they don't grow everything themselves, they have access to it through neighbour trades or sales. Additionally, if surplus produce becomes available, it can be sold to individuals or organizations such as school and university kitchens.

On a global level, productive gardens sustaining households and local areas have been largely replaced with larger industrial farms. Bringing back the smaller scale gardens and farms has multiple sustainability benefits including:

- **Transferring power back to individuals:** local people become the farmer/gardener and reap the benefits of fresh produce or profits as opposed to businesses collecting the benefits.
- **Bolstering local economies:** if gardeners choose to sell produce, livelihoods are created and profits return directly to farmers.
- **Reducing impact on the environment:** smaller scale farms tend to have reduced impacts on the environment compared to large scale industrial farms as produce transport is reduced, cost generally inhibits/decreases the use of heavy industrial chemicals and fertilizers and water is generally used more efficiently if gardeners/producers pay for it.
- **Increasing green space:** the increased presence of plants helps to mitigate climate change through the increased carbon sequestration capacity of areas; improves access to recreational areas for community members and; increases urban area aesthetics

North America is witnessing a new trend in urban agriculture - new developments including town-home developments, situated in the heart of the city, are including community gardens as integral design features.

Case Study: Cities without Hunger – Community Gardens, Sao Paulo, Brazil

*"The 'Cities without Hunger/Community Gardens Project' seeks to introduce a **sustainable alternative** to connect the **production of food in disadvantaged communities** with high population density in order to ameliorate the situation of those groups at risk. The Project **empowers** these communities to improve the social, environmental and economic issues affecting them. The project's objective is to implement - through a participatory process - a farming nucleus and many satellite agricultural sites in order to **generate urban job opportunities**; **skills-building** for participants and their dependents; **systematic income generation** from selling the produce and value added processed goods and, foremost, the **social integration** of the communities with their environments, both those that are natural and built."*

- UN Habitat for a better future (2010)

Program results: job opportunities created, income creation for the unemployed, increased awareness of sustainable land management, use of previously "void" urban areas, fostering and maintenance of biodiversity, securing of credit mechanisms for small scale farming and strengthened social awareness.

Sustainable Settlement, Infrastructure and Household Design

Planning new or improving older areas earmarked for urban development should include a detailed review of general inhabitant demographics, climate, local biodiversity, local economic activity and cultural values. Through assessment of these factors, vital information for planning sustainable urban areas is captured such as inhabitant's needs (e.g. transport infrastructure, schools, hospitals and areas conducive to social stimulation) and desires (e.g. centres of faith and green spaces for conservation, improved aesthetics and recreation). In this way, cities can be planned to optimize access to services and public transport, productive garden capacity and aesthetics whilst reducing resource demand and negative environmental impacts.

At the household level, green building design standards are followed to reduce environmental impacts and increase the health and well-being of inhabitants. Energy design features in green buildings consider the local climate. For example, in the tropics, the focus is on natural cooling methods as opposed to heating and creation of shady indoor and outdoor areas rather than increased solar penetration. Well designed houses take into account local climatic variables such as the sun's daily path and angle, predominant air flow directions, annual precipitation, natural hazards and the needs of inhabitants.

Additionally, the choice of building materials is important. Incorporating low impact environmental building materials (such as those previously used i.e. recycled) greatly improves the quality of life for inhabitants, through health benefits and cuts resource consumption.

Secure Land Tenure and Property Rights

As UN-Habitat notes, securing land tenure and property rights, especially for the poor and socially marginalized groups of society, is a key component of delivering basic human rights. Clear and fair property rights support economic development and social inclusion which is paramount at a time when slum dwellings are increasing, in countries such as Guyana, due to increased rural urban migration and expansion of urban centres.

Once rights are secured, recipients can invest in their homes, communities and livelihoods. Additionally, these rights help to promote better environmental management, reduce conflict (real and potential), improve food security and eliminate social discrimination against minorities such as women, poor and the indigenous. UN-Habitat goes further to encourage the development of land policies that protect people from forced evictions and removals. In situations where removal is deemed absolutely necessary, it is important to provide adequate compensation.

Exercise:

Build a composting organic waste recycling system at school!

There are many great resources for teachers to follow on how to set up a compost system at school and link this exercise to school curriculum. Some useful resources include:

School Grounds Transformation: Composting
http://www.schoolgrounds.ca/projects/composting.html

Recycle Now: Making compost at school

http://www.recyclenow.com/home_composting/schools/

School composting: A Manual for Connecticut Schools

http://www.ct.gov/dep/lib/dep/compost/compost_pdf/schmanual.pdf

Unit 15: Governance and the SLM model

Objective: *Summarize the global and local legislative and policy framework in place to support and complement SLM activities in Guyana.*

The right governance model, on global, national, regional and local levels, has the ability to promote and support the development and implementation of SLM. SLM related legislation, policy and institutions flowing from the right type of governance structure, whether voluntary or not, can provide a number of helpful mechanisms such as guidelines, incentives, disincentives, funding and enforcement.

This Unit focuses on good governance in terms of the international and national policy, legislative and institutional framework.

Governance at the International Level

There are a number of international conventions and programs aimed at addressing land degradation through the promotion of SLM. One such program, directly promoting SLM, is the United Nation's Convention to Combat Desertification (UNCCD) which Guyana ratified in 1997; another, with a more indirect link to SLM, is the Internal Convention of Biological Diversity which Guyana is a signatory to.

Ratification of the UNCCD signalled the acknowledgment that desertification, a form of land degradation, is a major sustainability problem. As outlined in the Guyana National Action Programme to Combat Land Degradation (2006), Guyana's commitments under the UNCCD are to:

- ☐Give priority to combating desertification and mitigating the effects of drought, and allocating adequate resources in accordance with circumstances and capabilities
- ☐Establish strategies and priorities, within the framework of sustainable development plans and/or policies, to combat desertification and mitigate the effects of drought
- ☐Address the underlying causes of desertification and paying special attention to the socio-economic factors contributing to desertification processes
- ☐Promote awareness and facilitating the participation of local populations, particularly women and youth, with the support of nongovernmental organizations, in efforts to combat desertification and mitigate the effects of drought; and
- ☐Provide an enabling environment by strengthening, as appropriate, relevant existing legislation and, where they do not exist, enacting new laws and establishing long-term policies and action programmes.

Policy and Legislative Environment in Guyana

Since the ratification of the UNCCD, Guyana has worked with the UN Development Program (UNDP) and the Global Financial Facility (GEF) to organize finance for, and development of, the Sustainable Land Management Project. Under this project, Guyana has:

- Developed a National Action Plan to combat land degradation. The Plan outlines key actions required to implement SLM activities.
- Assessed the status of land degradation in Guyana, on a national level. Findings are captured in a report entitled "National Assessment of Land

Degradation in Guyana: Diagnostic Report" published in 2008

- Increased awareness of land degradation and SLM. This has been achieved through the development of this Teacher's Guide, conducting training for local staff members and running stakeholder workshops on the topics, amongst other initiatives.

These projects have been managed, at the national level, by the Guyana Lands and Surveys Commission.

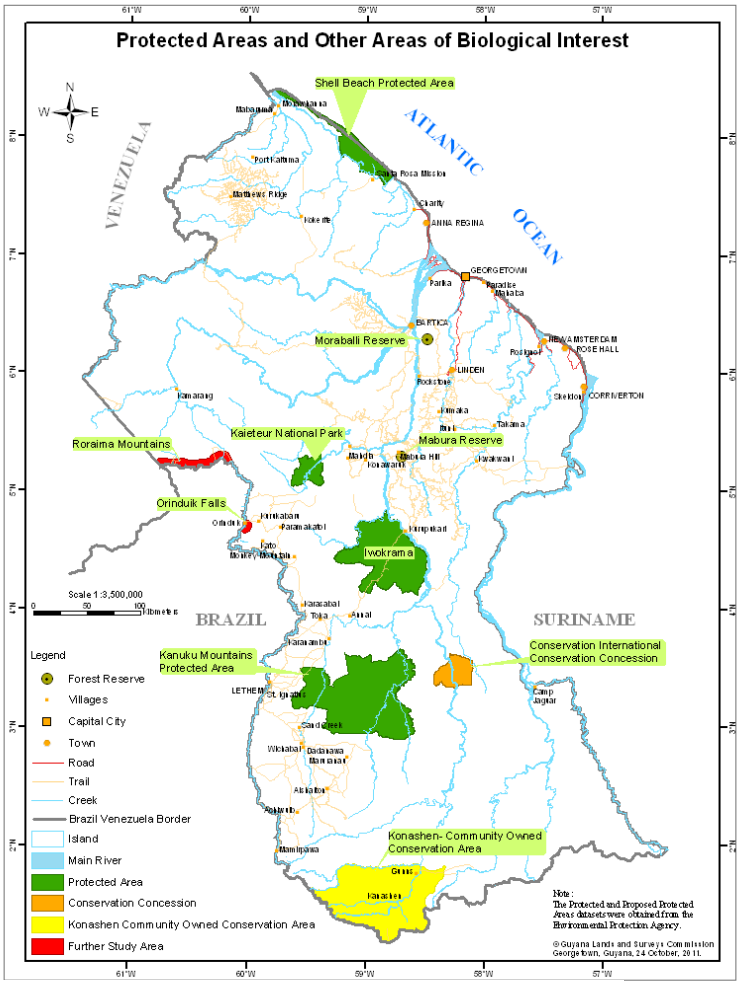
> Another local example of how international programs drive development of national level legislation and programs, is the introduction of the Protected Areas Bill in Guyana.

This Bill, following the confirmation of commitment to the Internal Convention of Biological Diversity, provides "for the protection and conservation of Guyana's natural heritage and natural capital; the creation, management and financing of a national system of protected areas …". The status of the establishment of Protected Areas is presented on the map on the right.

Stimulating Investment in SLM

The Guyana Lands and Survey Commissions (GLSC) in conjunction with the UNDP and GEF, are working on ways to stimulate investment in SLM in Guyana. These groups developed a report, "Incentives to Stimulate Investment in Sustainable Land Management", released in December 2011, which outlines key recommendations to create an enabling environment, conducive to encouraging and supporting innovative financial mechanisms. The key recommendations are:

- Recommend policy related to SLM for integration into national and regional plans
- Rationalise the land tenure system and revise the current leasing system



Protected Areas and Other Areas of Biological Interest

- Strengthen institutional capacity and governance
- Improve monitoring, reporting and verification capabilities over land resources
- Build local capacity; and
- Improve environmental awareness.

Good governance is a qualitative term or an ideal.

Good governance is:

- **Sustainable and locally responsive:** It balances the economic, social, and environmental needs of present and future generations, and locates its service provision at the closest level to citizens.
- **Legitimate and equitable:** It has been endorsed by society through democratic processes and deals fairly and impartially with individuals and groups providing non-discriminatory access to services.
- **Efficient, effective and competent:** It formulates policy and implements it efficiently by delivering services of high quality
- **Transparent, accountable and predictable**: It is open and demonstrates stewardship by responding to questioning and providing decisions in accordance with rules and regulations.
- **Participatory and providing security and stability:** It enables citizens to participate in government and provides security of livelihoods, freedom from crime and intolerance.
- **Dedicated to integrity:** Officials perform their duties without bribe and give independent advice and judgements, and respects confidentiality. There is a clear separation between private interests of officials and politicians and the affairs of government.

- Professor Stig Enemark, Aalborg University, 2009

Unit 16: Adaption and Mitigation of Climate Change

Objective: *To provide an overview of how SLM helps to address climate change and global warming.*

As discussed in Part 2, land-use change can be a significant contributor to greenhouse gas (GHG) emissions globally. But we must remember that land-use change has the ability to not only increase GHG emissions, but to decrease them! Additionally, implementation of SLM activities will help to both mitigate against, and adapt for, the impacts of global warming and climate change. This in turn will help to preserve ecosystem functions, ensure food security, use water more efficiently and address land degradation.

This Unit focuses on:

- Demonstrating how SLM practices can build tolerance to, and drive down impacts of climate change, and
- How we can move towards an active land and species management paradigm.

Building Tolerance to Climate Variability through SLM

Many SLM practices will help decrease the impacts of climate change. As TerrAfrica notes, "the most appropriate SLM practices... are characterized by tolerance to increased temperatures, to climate variability, and to extreme events. If the SLM principles of improved water, soil fertility and plant management, and micro-climate are considered, the result will be better protection against natural disasters and increased resilience to climate variability and change."

Table 2 below provides some examples of how agricultural SLM practices will help to mitigate against climate change impacts

Table 2. Climate change impacts and their associated agricultural SLM response and benefit (adapted from information provided by TerrAfrica 2009, 2006)

Climate change impact	Agricultural SLM practice addressing climate change impact	SLM benefit alleviating climate change impact							
		Creation of cool, shaded micro-climates	Reduced direct evaporation from soil	Decreased exposure of vulnerable crops and animals	Decreased pressure on town water supplies whilst improving fresh water supplies	Protecting soil from erosion	Protecting soil from exposure to extreme tempera-tures	Opportunity to diversify farmer income	Possibility of increased crop yields
Increased maximum day and night temperatures	Planting more trees (in practices such as Agro-forestry)	✓✓	✓	✓✓		✓✓	✓	✓	
	Multi-storey cropping	✓✓	✓			✓	✓	✓	
Dryer environments	Minimum tillage		✓			✓	✓		✓
	Improved grazing land management		✓			✓✓	✓	✓	✓
Dryer environments	Permanent vegetation soil cover	✓	✓✓			✓✓	✓		✓
	Mulch cover on soil		✓✓			✓	✓		✓
Decreased rainfall	Rainwater harvesting				✓✓				✓
	Drip irrigation				✓	✓			✓

Climate change impact	Agricultural SLM practice addressing climate change impact	SLM benefit alleviating climate change impact							
		Creation of cool, shaded micro-climates	Reduced direct evaporation from soil	Decreased exposure of vulnerable crops and animals	Decreased pressure on town water supplies whilst improving fresh water supplies	Protecting soil from erosion	Protecting soil from exposure to extreme tempera-tures	Opportunity to diversify farmer income	Possibility of increased crop yields
Increased storm activity	Shelterbelts / hedgerows	✓✓	✓	✓✓		✓	✓	✓	
	Arrest erosion		✓			✓✓	✓		

Implementation of SLM activities will also help decrease global GHG emissions through increased reduced tillage and improved grazing management all help to increase carbon sequestering efforts. Additionally, limiting activities such as deforestation and the application of fire will limit the amount of greenhouse gas emissions released to the atmosphere.

Case Study: Introduction of integrated silvo-pastural systems for farms in Columbia, Costa Rica and Nicaragua

What is an integrated silvo-pastural system? *It is a system which integrates the production of livestock and trees within one integrated pasture system.*

Results: *71% increase in carbon sequestration, reduced run-off, reduced erosion, increased product resilience, improved biodiversity, water quality improvement, increased production and more!*

Source: FAO, 2009

Active Management Paradigm

Global warming and climate change necessitate that we move from a preservationist /conservation land and species management paradigm, towards an active management paradigm. This paradigm shift results from the fact that environments and species habitats, as we know them, are in a state of flux; active management is required to understand changes as they happen.

One example of the application of active species management is “assisted migration”. Assisted migration describes a process whereby, humans interfere with natural occurrences in the interests of boosting species survival during the onset of climate change. We know that as a result of climate change and global warming, environments will change. Generally speaking, environments will become warmer and dryer (but it is possible that some environments will become cooler and/or wetter). As a result of changing environments, it is predicted species will move to more favourable climates. Again, generally speaking, scientists predict species will tend to shift north.

Key findings can be summarized as follows:

- **Plant species assisted migration**: we already have established nurseries, seed orchards and trained tree planters. These enabling factors combined with an understanding of future changes to local areas, make us well-equipped to deal with plant species assisted migration.
- **Animal species assisted migration**: Species introduction to new areas “artificially” is generally viewed as dangerous and should be avoided. Other alternatives include increasing the size of protected areas and increasing the number of species corridors to facilitate the avoidance of obstacles such as urban environments, roads and industrial activity.

There are of course social and biological risks which need to be rigorously analysed before assisted migration takes place.

EPA Guyana: Bird Watching

Globally, only 8% of biomes, in protected areas, will still exist in their current boundaries by the end of this century!

Application of the precautionary principle (introduced in Part 2) combined with the fact that risks associated with inaction are far greater than the risks associated with action, provide great reasons to act now!!!

Case Study: Assisted migration of the White Bark Pine tree, B.C. Canada

In British Columbia, Canada, scientists have been planning ahead for the longevity of the White Bark Pine tree. The tree is a key ecosystem species as it supports the life of many other species. The tree provides food for grizzly and black bears and needs the help of nutcracker birds to regenerate. Scientists have been planting the species outside of its "native range" in areas that they predict will provide optimal climate for the species by the end of this century.

Case Study: Using alternative sources of energy

More and more communities are starting to use energy sources other than fossil fuels which are associated with significant greenhouse gas emissions not to mention the fact they are not renewable!

Some examples of technology that don't combust fossil fuels include:

- **Biodigesters:** these machines convert organic wastes into liquid fertilizer and biogas, a renewable source of electrical and heat energy. They provide a cheap source of fuel and reduce diseases caused by the use of untreated manure as fertilizer.
- **Solar cookers:** these devises harness the energy from the sun to heat and cook food and/or boil water.

Unit 17: Valuing Scientific and Indigenous Knowledge

Objective: *To outline the importance of continued and increased inclusion of the voices of indigenous people and scientists in SLM.*

To optimize SLM it's important to continue to seek out and incorporate the "voice" of local indigenous people and scientists – their ideas, opinions, advice, knowledge and expertise. These two groups bring expertise, local knowledge and different view-points to SLM in slightly different ways:

- **Indigenous people:** these people have highly specialized knowledge about their local areas which has been built upon through information sharing passed down through many generations. Traditional societies are in tune with the seasons and the temporal and spatial dimensions of interrelationships between climate, ecosystem services and products and species.
- **Scientists**: these people are experts in their field, they have spent years hypothesising, reviewing peer's work, collecting data, analyzing and concluding on scientific phenomena across a broad range of disciplines highly relevant for SLM including agriculture, conservation biology, fire ecology, landscape ecology, water hydrology, food science and social ecology.

Including the Voice of indigenous people in SLM

As the Secretariat of the Convention on Biological Diversity (SCBD) states, traditional/indigenous people's dependence on forests is "deeply rooted in history and long predates modern social change." Often, the cultural and spiritual identity of indigenous people is directly tied to healthy functioning ecosystems and rich biodiversity. Some communities believe there is no separation between their minds and bodies and that of the forests, waterways, plant and animal species, earth, fire and wind. With this deep connection to nature, indigenous people are generally well aware of the seasonality of ecosystem services and products available.

> The SCBD outlines that in the Amazon basin, knowledge of the medicinal, nutritional and cultural uses of over 1,300 different forest plant species is "common knowledge" in local indigenous communities

There are around 400 million indigenous people across more than 70 countries, many of whom live in tropical areas. Many of these people depend on particular ecosystems around the world. It is estimated that globally 60 million indigenous people are directly dependent on forest ecosystems and forest products. Forests provide resources such as food, medicine, water and wood. Disturbingly, more and more we are seeing competition for access to resources between companies and indigenous people and a disrespect for their spiritual and cultural beliefs and sacred sites.

We have the power to avoid the exploitative model! For example, in Brazil, the acaí palm provides up to 42% of total food intake by weight for the indigenous

population and is used for making day to day items such as hats, baskets, brooms and thatched roofs. In the last few years the acaí berry has become a popular high value food item sold all over the world. There are opportunities here to avoid the exploitation model and work with indigenous communities to sustainably manage the forest to ensure the continued provision of ecosystem services, protection of indigenous people's access to the acaí palm and equitable distribution of funds from commercial harvests.

Article 8(j) of the global Convention on Biological Diversity aims to respect, preserve and promote traditional knowledge. This convention recognises the importance of indigenous and traditional knowledge, innovations and practices and the interdependence of these people and the ecosystems they depend on and/or a part of.

So how do we include and amplify the indigenous voice in SLM? We need to include indigenous representatives up-front at the SLM project planning phase for all new projects (but remember it's never too late in the project life to start this process!) It is important to include indigenous people in decision making and governance. Through this process, the aim is to garner "free, prior and informed consent" to any project, plan or other change which impacts communities, lifestyle and environment. To provide indigenous stakeholders with a comfortable way in which to voice their values, ideas, experience, advice and opinions, SCBD suggests the following:

- Improved education and awareness-raising
- Indigenous to indigenous transfer of knowledge and
- Capacity building.

Government, business and indigenous parties need to be involved in all of these processes sharing the roles of funder, facilitator and participant.

New research published in the Journal of Latin American Geography, conducted within the native **Wapishana and Makushi communities of Guyana**, suggests that indigenous cultural beliefs such as **shamanism help preserve tropical forests and wildlife**. The research shows that **hunters avoid spiritual sites**, potentially creating **animal refuges**. Additionally, hunting practises are not very intense and to date, no major reductions in species populations including extinctions have been evident.

Case Study: Including indigenous people in project operations – diversifying their income, Congo

The Congolaise Industrielle des Bois (CIB) was prompted to work with local indigenous people, the Mbendjele pygmies, when they were chasing compliance with the Forest Stewardship Council for their work in 1.3 million hectares of the Congolese forest, home to 9,000 Mbendjele pygmies.

The pygmies and CIB worked together to first identify and then protect sites of special cultural, ecological, economic and religious significance to the pygmy people.
There were challenges, such as language barriers, but these were able to be overcome through engagement of partner organizations and anthropologists familiar with this group of local indigenous people and their lifestyle. Working together, they used geographic information system (GIS) technology to map out their important areas and keep them free from logging.

Source: SCBD, 2009

Improving Input from scientists on SLM

Scientists are people who dedicate their life to the search for knowledge. Note, they are not always great at disseminating knowledge – there are probably thousands of really interesting, shocking and important findings that never make it past the pages of obscure and hard-to-read academic journals! They need our help to make sure their important ideas are included.

Scientists are usually some of the first people to raise our attention about serious issues. Did you know the concept of human induced global warming was first discussed in the 19th century? It then became popular again in the 1950s and 1960s but it wasn't until 1988 that the Intergovernmental Panel on Climate Change was developed and it is only just recently that countries are actually agreeing with scientists and publicly declaring they believe humans are changing the climate.

Scientists dedicate their professional careers to studying a myriad of subject matter related to SLM. Some related scientific subjects are detailed on the following page.

Agriculture	Ecology	**Social ecology**
Biology	**Soil chemistry**	Linguistics
Fire ecology	Psychology	Conservation
Food science	Geography	**Mathematical modelling**
Physics	Water hydrology	Biochemistry
Animal physiology	**Animal husbandry**	Finance
Computer science	Statistics	**Social science** Planning
Architecture		**Urban design**

Through SLM, we can help incorporate peer-reviewed scientific knowledge to:

- **Support SLM action:** often scientific findings provide the catalyst to initiate action. For example, we know scientists have predicted sea level rise on the coastal shores of Guyana which is a great reason to stop mangrove forest destruction and cease the building of new houses and infrastructure close to the shore line, among other actions.
- **Inform SLM action:** scientific research, as well as other information such as indigenous knowledge and local community perspectives, should feed into the development of SLM actions. Scientists will help to identify which actions are appropriate in different areas.
- **Monitor, analyse and improve SLM action:** scientists can be on hand to monitor SLM actions in progress, analyse results and provide continuous evaluation throughout the implementation process. This can help establish new actions and help determine the suitability of different actions in different areas.

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Glossary

Alluvial soil	**A fine grained soil deposited by water flowing over flood plains or in river beds.**
Anthropogenic	Meaning human-induced or caused by human activity.
Artisanal mining	Small-scale mining, sometimes it is purely manual.
Biocapacity	Refers to the capacity of a given biologically productive area to generate an on-going supply of renewable resources and to absorb its spillover wastes.
Biodiversity	The variability among living organisms within species, between species, and between ecosystems.
Biofuel	A fuel derived from renewable resources such as plants.
Biome	A major regional or global type of ecosystem such as a desert or forest.
Brownfield site	Abandoned or underused industrial and commercial facilities available for re-use.
Carbon sink	A reservoir that is a net importer of carbon dioxide, done through accumulation and storage of carbon dioxide. For example, a forest.
Carcinogen	A substance or agent that is detrimental to human health.
Climate change	Long-term change in the earth's climate due to an increase in the average atmospheric temperature.
Desertification	The degradation of land in arid, semi-arid and dry sub-humid Areas. It is caused primarily by human activities and climatic variations.
Ecological footprint	A measure of a human or a project's demand on the earth. It measures the amount of productive land required for products and services such as food, transport, water, housing, waste management etc.
Ecosystem services	The benefits that people and economies gain from ecosystems. Biodiversity underpins the proper functioning of ecosystems and ensures the delivery of ecosystems services.
Environmental Management System	A framework that helps companies achieve environmental goals.
Eutrophication	A process whereby water bodies receive too many nutrients for what they can process properly. It leads to excessive plant growth in the water body.
Fibre	The output of farming and forestry activities not including food, such as wood products, cotton etc.
Global warming	Refers to the rising average temperature of Earth's atmospheric temperature.

Greenfield operation	**Operations conducted in a once productive area, for example, an area covered in a healthy grassland.**
Greenhouse effect	The phenomena whereby Earth's atmosphere traps solar radiation.
Greenhouse gas	Any atmospheric gas that is able to help trap solar radiation in the Earth's atmosphere. Common examples include carbon dioxide, methane and nitrous oxide.
Hypoxia	Describes a condition in which there is a low level of oxygen in a water body.
Monoculture	The cultivation of a single crop on a defined area.
Mulch	A protective layer of organic matter such as residue of harvested crops, grass, leaves, straw or peat placed on top of soil.
No-till	A system for planting crops without plowing. Herbicides may be needed to control weeds.
pH level	It is a measure of the acidity or basicity of an aqueous solution. Neutral pH is said to be 7. Less than 7 is said to be acidic, greater than 7 is said to be alkaline or basic. The scale is from 1 through to 14.
Reclamation	The restoration of mined land to original contour, use and condition.
Riparian zone	The area between a water body (usually a river or stream) and the land i.e. the river shore.
Sustainability	A paradigm by which nature and people live in harmony. The three pillars of sustainability are people, the environment and the economy. The three pillars need to be healthy in order for the paradigm to work.
Tillage	A process by which soil is loosened and sometimes other substances are mixed into the soil such as fertilizer and/or plant material.
Triple bottom line accounting	The reporting of financial, social and environmental effects and performance.

Acronyms - organizations and reports

FAO	**United Nations Food and Agriculture Organization**
GEF	The Global Environment Facility
GLSC	Guyana Lands and Surveys Commission
ICMM	International Council on Mining and Metals
IPCC	Intergovernmental Panel on Climate Change
NALDG	National Assessment of Land Degradation in Guyana
UNEP	United Nations Environment Programme
UNDP	United Nations Development Programme
WHO	World Health Organization

Appendix A: Sample Lesson Plans

During the Teacher Training on the Resource Guide, held in Guyana, late January 2012, teachers were asked to develop lesson plans related to land degradation and SLM material provided in the Guide. A sample of lesson plans were chosen for inclusion in the Guide, and they are listed below.

Sample Lesson Plan #1 **Urbanization: Effects of urbanization in Guyana**	
Lesson plan topic :	Urbanization: Effects of urbanization in Guyana
Lesson objectives:	After viewing a 10 minute documentary on urbanization in the world's major cities, students should be able to: 1) Identify 5 effects of urbanization in Guyana with 90% accuracy 2) Outline clearly at least 3 impacts of these effects on ecosystems 3) Recommend at least 3 conservation practices to reduce the impact of urbanization on the ecosystems that are realistic.
Target class level:	Form 10 A
Duration:	70 minutes
Assumed knowledge:	Students are familiar with the term and concept urbanization.
Applicable sections of Guide:	Unit 8: Human Settlement Unit 14: Sustainable urban settlements
Links to syllabus:	► Biology: Section E ► Agriculture: Section A, Units 2 & 3 ► Integrated Science: Section B, Units 2 & 3 ► Geography: Sections III and IV
Classroom activities: **A. Student activity**	**B. Teacher activity**
► Ask and answer questions from the teacher	► Inform students of the objectives of the day's lesson and briefly reuse previous lesson/documentary by asking questions
► View documentary – global focus on major cities of the world	► Instruct students to view documentary

Sample Lesson Plan #1 **Urbanization: Effects of urbanization in Guyana**	
► Identify the effects of urbanization seen on the documentary	► Divide students into groups and instruct them to identify the effects of urbanization as seen in the documentary
► Coming up with effects of urbanization in Guyana	► Instruct each group to come up with effects of urbanization in Guyana
► Come up with at least 2 impacts of urbanization on the ecosystems of Guyana ► Recommend practices to reduce the impacts of urbanization on the ecosystem	► Instruct students from each group to come up with 2 impacts of urbanization on the ecosystem in Guyana and recommend conservation practices to reduce the impacts of urbanization on the ecosystem
► Write letters to the Mayor of Georgetown (or other Province) about the effects of urbanization in Georgetown and how to reduce these impacts of urbanization on ecosystems	► Instruct each group to write a letter to the Mayor of Georgetown about the effects of urbanization in Georgetown and the measures that can be used to reduce these impacts of urbanization on the ecosystem
► Students summarize lesson orally	► Instruct students to orally summarize lesson base on objectives and content covered.

Sample Lesson Plan #2 **Agricultural practices to promote soil and water conservation**	
Lesson plan topic :	Agricultural practices to promote soil and water conservation.
Lesson objectives:	With the aid of models and pictures, students will: 1) State correctly the importance of soil and water conservation. 2) Explain 2 methods of soil and water conservation
Target class level:	Level 10
Duration:	70 minutes
Assumed knowledge:	Familiarity with the concept of soil erosion
Applicable sections of Guide:	Part 2, Units: 5,6 and 7

Sample Lesson Plan #2
Agricultural practices to promote soil and water conservation

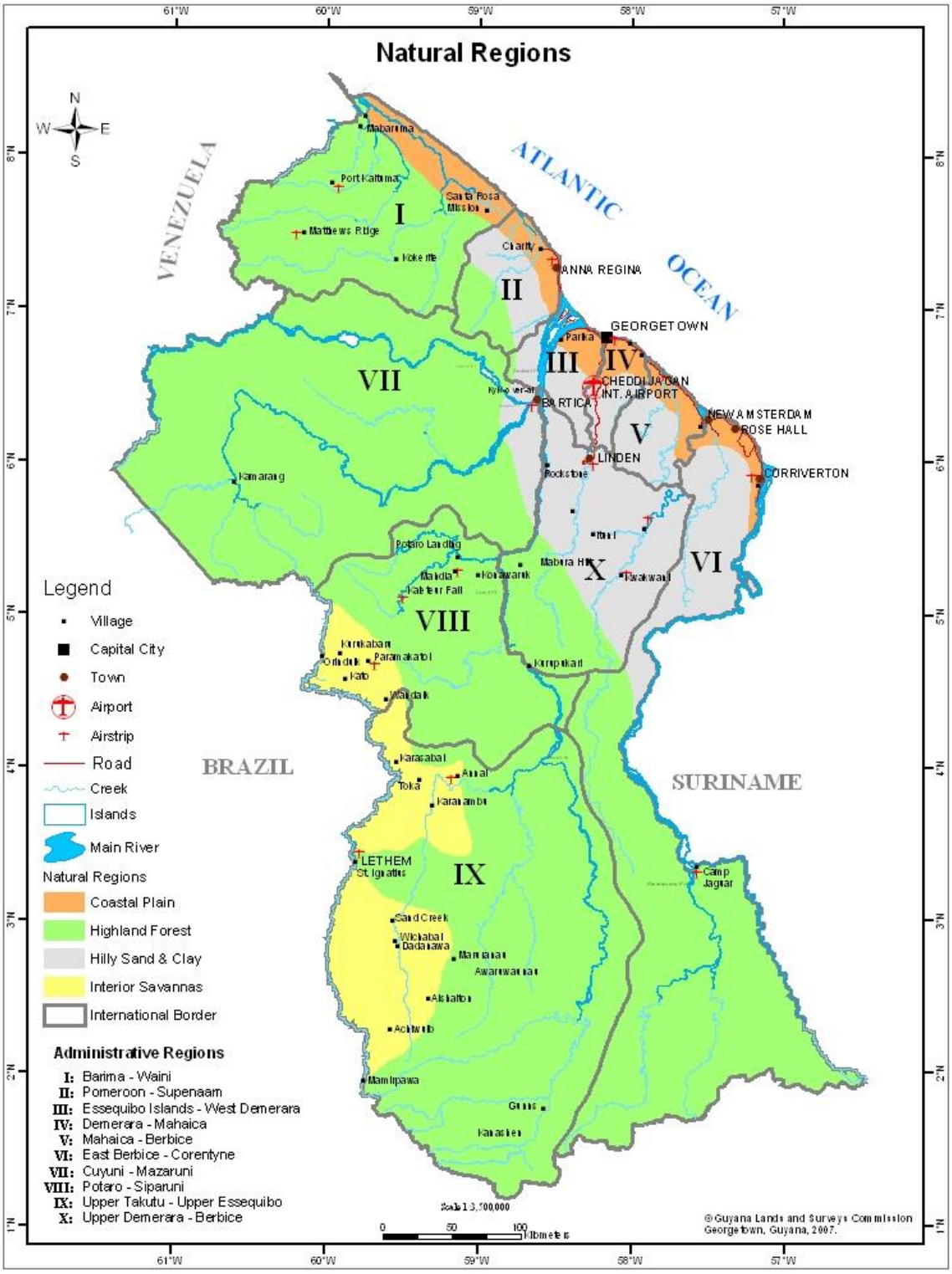
Part 3, Units: 11,12 and 13

Classroom activities:

Teacher activity	**Student activity**
STAGE 1 ► Display pictures of different types of erosion and land degradation. ► Ask students the following questions: 1) What do you think is going on in the picture? 2) What effects will these situations have on the environment? ► Discuss responses related to the topic and objective of the lesson STAGE 2 ► Display models of a farmer cultivating crops in a hilly area, on a slope: ► Model 1: Terracing model ► Model 2: No terrace ► Use a watering can to imitate the effect of rain on the slope ► Ask students to observe and compare the effects of each model STAGE 3 ► Display pictures of splash erosion and ask students what they think can be done to prevent it. ► Show students pictures of a sweet potato/pumpkin farm. Tell students that this method of conservation is called vegetative cover. CONCLUSION ► Recap lesson by highlighting key points.	Observe pictures and respond to teacher's questions.

Sample Lesson Plan #3 **Forestry Practices that cause land degradation**	
Lesson plan topic :	Forestry practices that cause land degradation and sustainable forestry practice alternatives. Sub-topics: 1) Illegal logging 2) Growth in the industry 3) Traditional market preferences 4) Intensive harvesting in reefs 5) Poor enforcement practices
Lesson objectives:	At the end of the lesson, students will be able to: 1) List 5 activities that lead to land degradation 2) Discuss at least 3 impacts these activities will have on the forest 3) Make 4 recommendations on how impacts and land degradation can be reduced
Applicable sections of Guide:	Part 2, Unit 6 Part 3, Unit 12
Classroom activities: **Teacher activity**	**Student activity**
► Outline the objectives of the lesson ► Distribute newspaper clippings to students and ask them to read through them	► Students read through a random selection of newspaper clippings
► Divide students into a few groups ► Ask students to list 5 ways which the forest could be degraded ► Facilitate the reporting of group findings to the class ► Encourage discussion with students on this topic ► Ask students to suggest ways by which the activities listed can be reduced ► Ask students questions at random	► Students participate, respond to teacher's questions and report back to the class on group findings
► Teacher uses a concept map to summarize the main points of the lesson ► Teacher gives students an oral quiz	► Students help the teacher develop the concept ► Students answer teacher's quiz questions

Sample Map for Classroom Exercises



Teacher's Notes