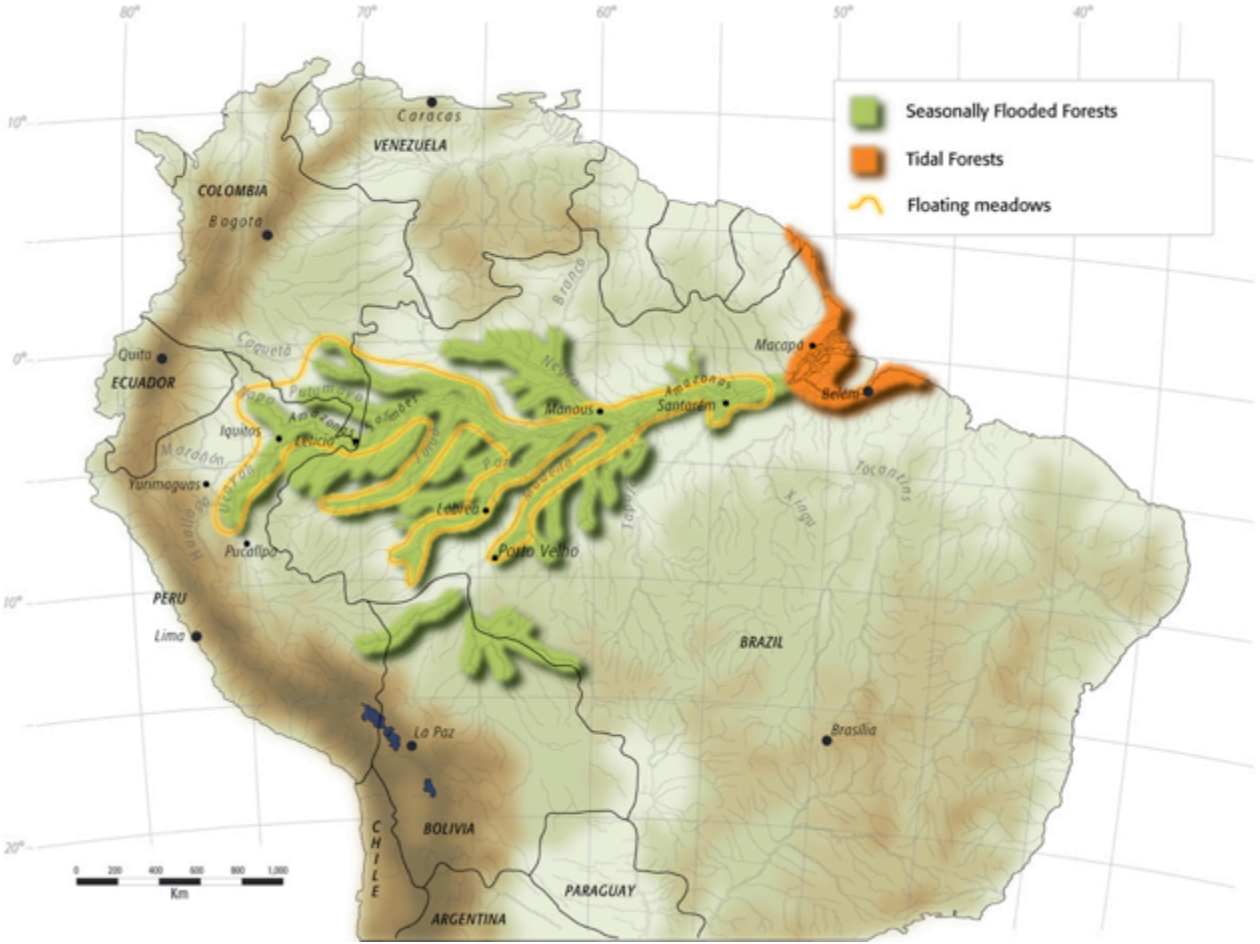
BIOL 448C – Exploring tropical habitats

Tutorial 1 – January 9, 2020

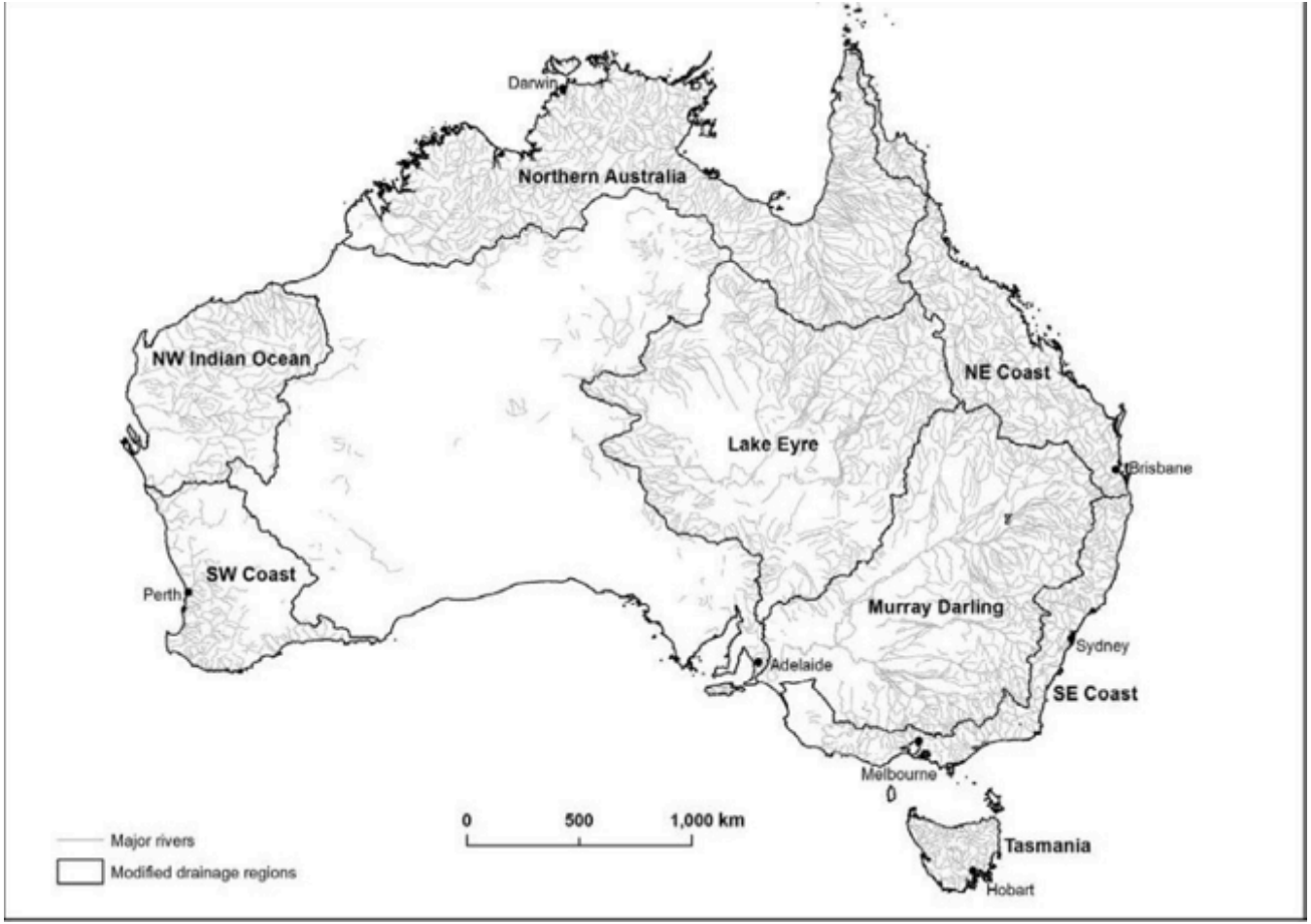
River/floodplain forest

By Hayley, Tatiana and Eliza



http://amazonwaters.org/fisheries/geography/floodplain-or-varzea/

- Forest floodplain distribution in the Amazon
- Floodplain forests cover approximately 14% of the Amazon Basin

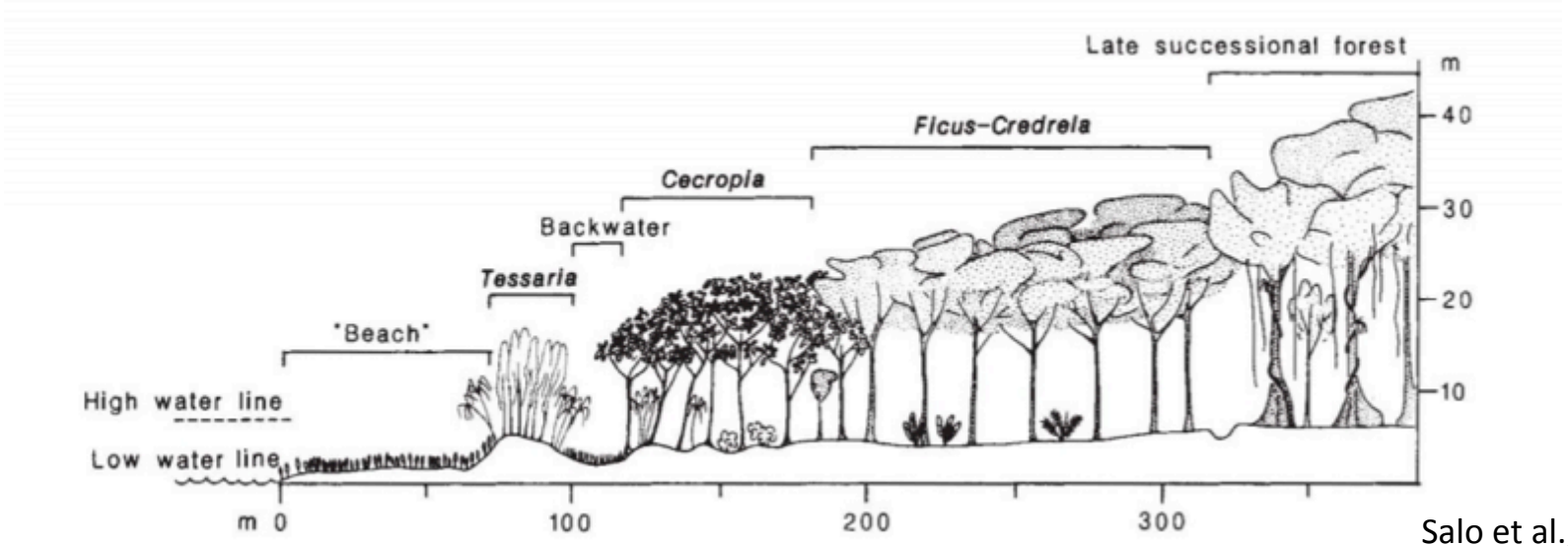


- Floodplain distribution throughout Australia

https://www.researchgate.net/publication/325976764_Forests_and_Woodlands_of_Australia's_Rivers_and_Floodplains

Vegetation

- Dynamic nature of river/floodplain forest, periodic flooding
- Different patches of forest will be at different successional stages
- Mostly seasonally inundated evergreen moist tropical forest
- Flooding carries lots of nutrients to soils



Salo et al., 1986

Key species

Tropical plants:

- High densities of fruiting trees
- Some palm species

https://fineartamerica.com/featured/flooded-amazon-rainforest-oliver-j-davis-photography.html

Animals:

- many lizard species including basilisk lizard aka Jesus Christ lizard
- Snakes (Great anaconda)
- 681 bird species
- Over 200 mammal species

https://www.icr.org/article/jesus-lizard-runs-water-tramples-evolution

Species richness/endemism

- High levels of endemism in heavily flooded areas
- Many distinct habitats generated by flooding can support many species
- 130 tree species endemic to South American floodplains (68 in Amazon) (Wittman et al., 2017)
- Lots of endemic bird species including white-eyed robin, scaled spinetails, red-shouldered macaws, sun parakeet and stygian owls (WWF)
- Endemic mammals including marmosets, bats and titi monkeys (WWF)

https://nationalzoo.si.edu/animals/titi-monkey

https://thefinchfarm.com/conure-sun/

Floodplain Forest General Climate

https://www.overflightstock.com/media/cb97b6b7-b6af-4cc2-bc74-cc015451fd64-anavilhanas-archipelago-in-the-rio-negro-and-flooded-forest-or

- Found in lowland areas, typically at elevations less than 500 m above sea level
- Found in areas with high annual rainfall (2400 to 3000 mm annually) that varies seasonally
- Found in warm climates around 26-29℃, which have little seasonal variation

Anthropogenic pressures:

South America

- **Most threatened ecosystems in South America**
- Deforestation: logging of kapok and virola trees
- Oil exploration in Peru
- Animal agriculture (cattle + water buffalo)
- Over fishing: extinction of river dwelling species , loss of traditional territory and sustenance fishing for indigenous people
- Poorly planned dams disrupt season cycles

/en.mercopress.com/2009/08/08/brazil-and-peru-considering-g-five-hydroelectric-dams

https://www.nationalgeographic.com/news/2015/04/150419-amazon-dams-hydroelectric-deforestation-rivers-brazil-peru/

Anthropogenic pressures:
Africa

- Conversion of land to pastor
- Water extraction for human use, agriculture, and industry
- As warming increases, water need may override conservation efforts

https://www.britannica.com/place/Ruvubu-River

Tropical wetlands provide vital ecosystem services to humans and are import to conserve!

- Carbon storage
- Flood protection
- Bioproduction, agriculture, fisheries
- Nutrient recycling and distribution, storage, maintain water quality
- Recreation
- Transportation via rivers

https://ecology.fnal.gov/ecosystem-services/

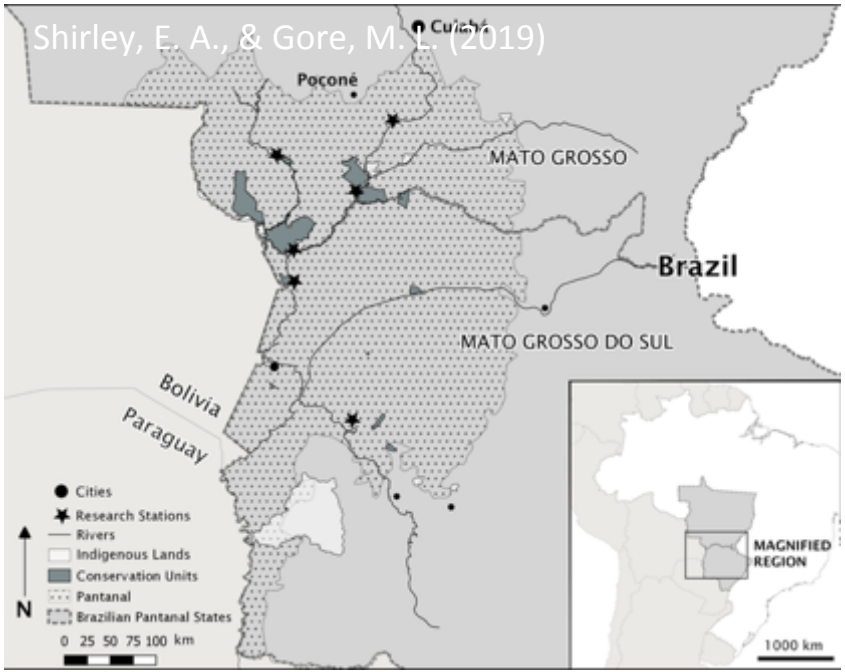
Major protected areas

Pantanal – World's largest wetland

Pantanal Matogrossense National Park -> 1,350 square km

SESC Pantanal Private Natural Heritage Reserve -> 878.7 square km

UNESCO -> 187,818 ha



https://www.nathab.com/blog/11-facts-about-the-pantanal-wetlands/

Major protected areas

South Africa

- iSimangaliso Wetland Park- South Africa's 3rd largest reserve

  UNESCO World Heritage Site, the 3,320 square km

  Various ecosystems including flood plains (St. Lucia Lake)

- Nylsvley Private Nature Reserve

  -> conservation of Roan antelope and Tsessebe

http://www.botswana.co.za/tsessebe--botswana-wildlife-guide.html

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https://whc.unesco.org/en/list/999/

https://wwf.panda.org/knowledge_hub/where_we_work/amazon/about_the_amazon/ecosystems_amazon/floodplain_forests/?

https://www.worldwildlife.org/ecoregions/nt0141

https://www.fs.usda.gov/nfs/11558/www/nepa/98306_FSPLT3_4130975.pdf

http://www.unesco.org/archives/multimedia/document-4681

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Volume 4 of The IUCN Wetlands Programme
https://books.google.ca/books?id=8oeYz0Oju9QC&dq=floodplain+water+harvesting+africa&source=gbs_navlinks_s

https://www.nature.org/en-us/what-we-do/our-priorities/protect-water-and-land/land-and-water-stories/benefits-of-healthy-floodplains/

https://www.sa-venues.com/game-reserves/nylsvley.php

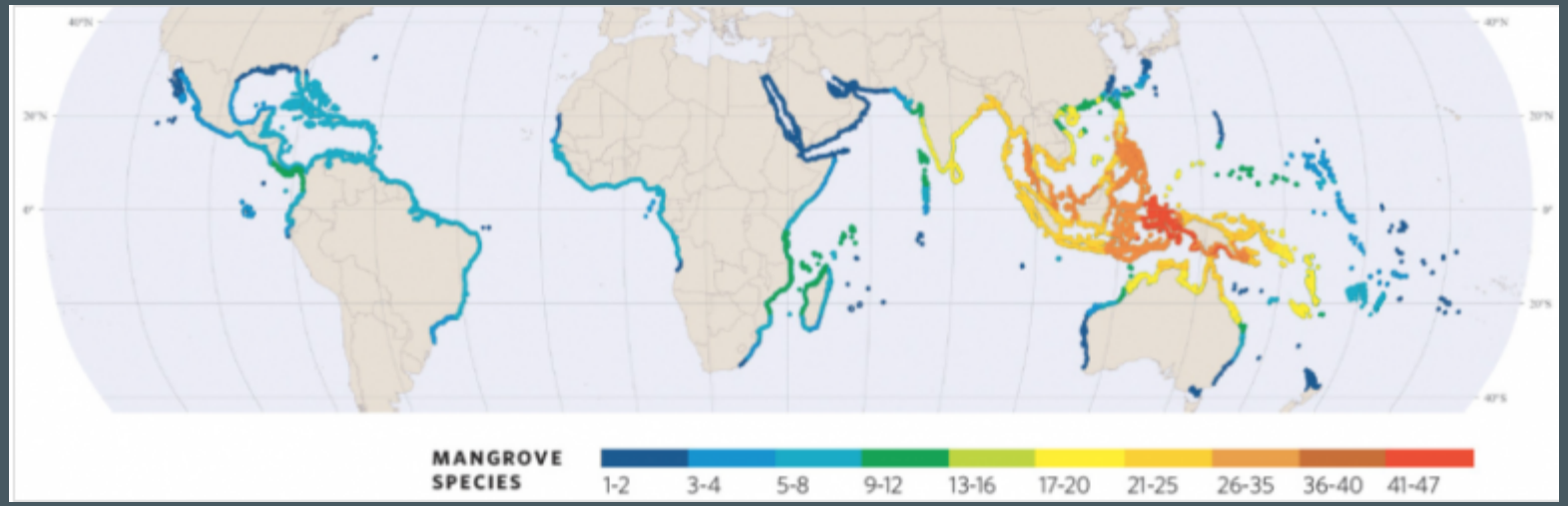
https://www.discoverafrica.com/safaris/south-africa/isimangaliso-wetland-park/

Mangroves

Katie Earle, Geoffrey Lau, Saba Shahrasebi, Nick Froese

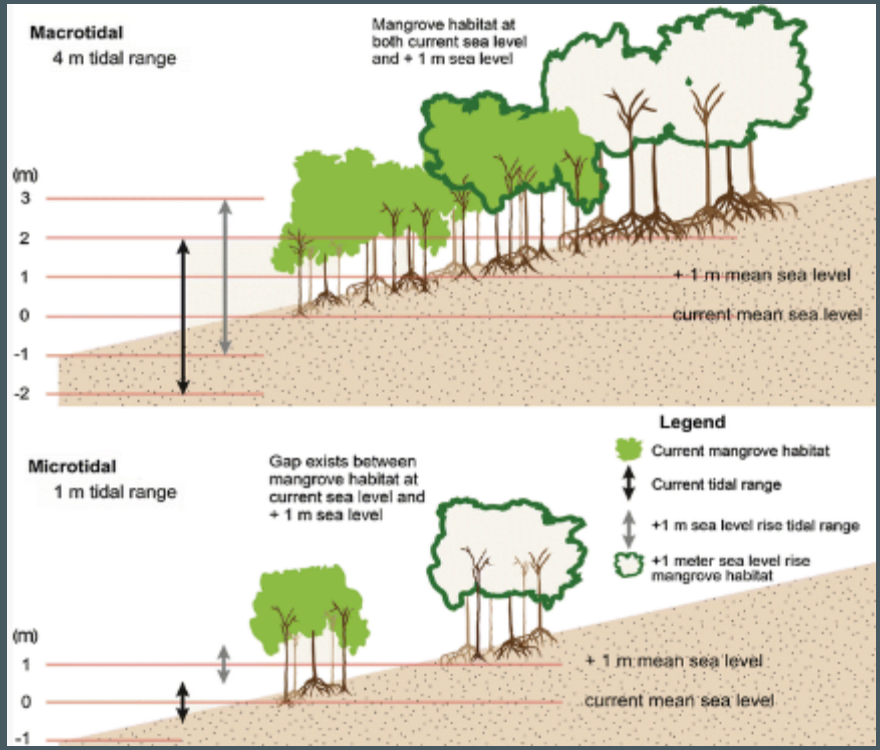
Global Distribution

- Distribution is divided into two hemispheres: Atlantic East Pacific and Indo West Pacific
- Cover an approximate area of 150,000 km^2 of sheltered coastlines, which is about 50% of their historical range.
- Distributed within the tropics and subtropics, reaching their maximum development between 25°N and 25°S



Elevational Distribution

- Primarily located between mean sea level and high tide elevations
- Mangroves in macrotidal areas have a larger lateral extent than those in microtidal areas
- Sea level rise will cause a greater relocation of intertidal habitats in microtidal areas relative to macrotidal areas



Climate

Mangroves generally occur in areas with high rainfall, however can thrive in relatively arid environments under certain circumstances.

Desert mangroves in Baja california

Mangrove forests require year round warm temperatures, usually above 25 degrees celsius. In some places such as florida, warming temperatures has led to the expansion of mangrove forests.

Flagship Species: Mangroves

Mangroves: a common name for trees/shrubs that live on tropical coastlines, typically rooted in saline sediment and often inundated with saltwater/brackish water

- 77 species across 21 genera
- Ecosystem engineers - their root and trunks structures create habitat for amphibians/ invertebrates/fish
- Specialized to live in salty and oxygen poor environments

Key Vegetation features

Pneumatophores: Specialized above ground roots capable of taking up oxygen from the atmosphere

Stilt roots: Roots stretching out from the main stem before penetrating the ground, adding stability.

Their complex root systems promote biodiversity by creating important nursery habitat for many species of fish.

In addition, they act as an important bioshield, protecting coastal areas from ocean storms and tsunamis.

Species Richness and Endemism

- Mangrove forests are important habitats for many species of crustaceans, molluscs, reptiles, amphibians, and birds
- The Mangrove Hummingbird (*Amazilia boucardi*) is a hummingbird species endemic to mangrove forests containing the Pacific Mangrove
- The Mangrove Tree Crab (*Aratus pisonii*) is endemic to the mangrove forests of the Americas
- *Sonneratia* mangroves are pollinated by bats that consume its nectar

Other (not necessarily endemic) Species

- Saltwater Crocodile (*Crocodylus porosus*) resides in the mangrove forests of Australia
- Fiddler crabs (*Uca* spp.) burrow in the mud below mangrove trees
- Mudskippers inhabit mangrove forests of the Indo-Pacific region
- The isopod *Sphaeroma terebrans* burrows into the prop roots of mangrove trees, which causes them to easily snap

Anthropogenic pressures

- Harvesting of fish products
  - Fish
  - Crabs
- Pollution
  - Liquid and solid waste dumped into ecosystem
  - Fertilizers
  - Oil
- Climate change - rising sea levels

(Rakovomato et al., 2018)
(WWF, 2019)

Anthropogenic pressures - infrastructure

- Dams and Irrigation
  - Change water levels in Mangroves
  - Tree decay
  - Biodiversity loss - plants and animals

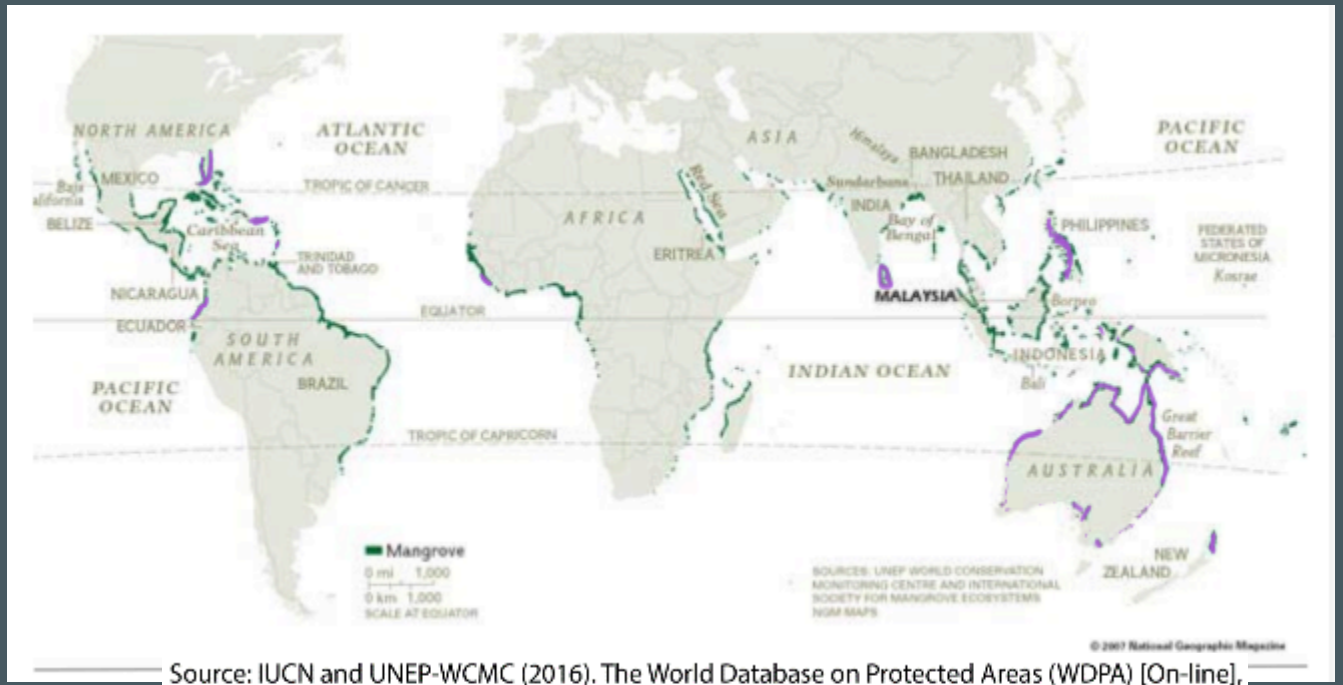
- Clearing and Backfilling
  - Converting land for agriculture

(Rakovomato et al., 2018)
(WWF, 2019)

Major Protected Areas

Purple areas >10% protected

- USA
- Australia
- Indonesia
- Philippines
- Costa Rica



Source: IUCN and UNEP-WCMC (2016). The World Database on Protected Areas (WDPA) [On-line], April 2016, Cambridge, UK: UNEP-WCMC. Available at wwww.protectedplanet.net

Major Protected Areas

List of World Heritage Protected Sites

From: United Nations Educational, Scientific and Cultural Organization

(UNESCO, 2010)

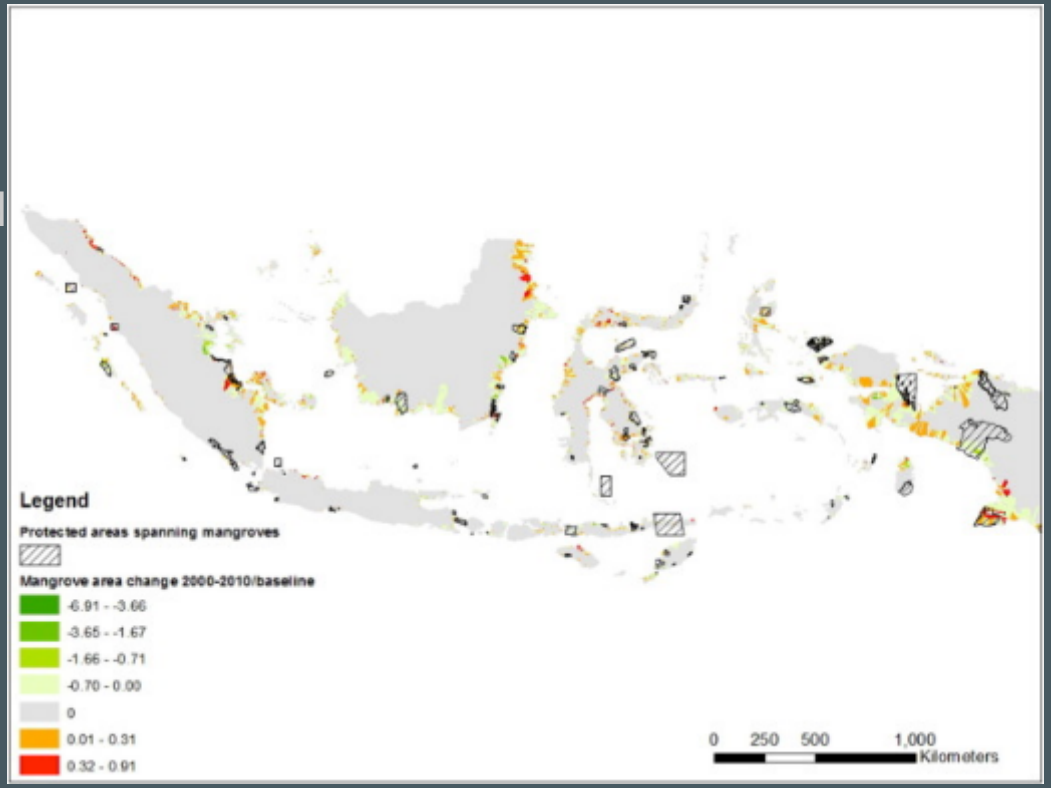
Galápagos Islands Ecuador
Everglades National Park USA
Great Barrier Reef AUS
Aldabra Atoll Seychelles
Sian Ka'an Mexico
Sundarbans National Park India
Ujung Kulon National Park Indonesia
Komodo National Park Indonesia
Puerto-Princesa Subterranean River National Park PHilippines
Tubbataha Reefs Natural Park Philippines
Belize Barrier Reef Reserve System Belize
The Sundarbans Bangladesh
Cocos Island National Park Costa Rica
East Rennell Solomon Islands
Area de Conservación Guanacaste Costa Rica
Brazilian Atlantic Islands: Fernando de Noronha and Atol das Rocas Reserves Brazil
Lagoons of New Caledonia: Reef Diversity and Associated Ecosystems France
Coiba National Park and its Special Zone of Marine Protection Panama
Malpelo Fauna and Flora Sanctuary Colombia
Phoenix Islands Protected Area Kiribati
Papahānaumokuākea USA

Major Protected Areas

Protected areas in Indonesia

- Research shows that protected areas decreased mangrove loss over time

(Miteva et al., 2015)



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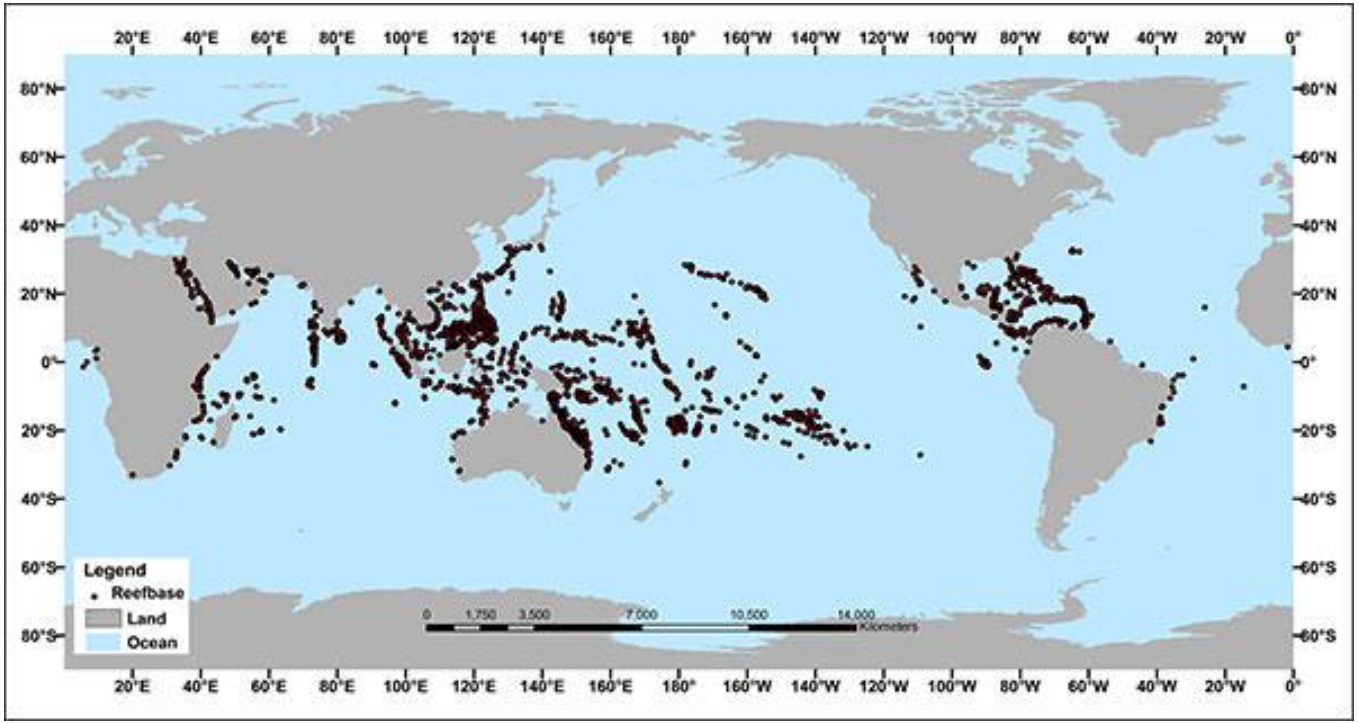
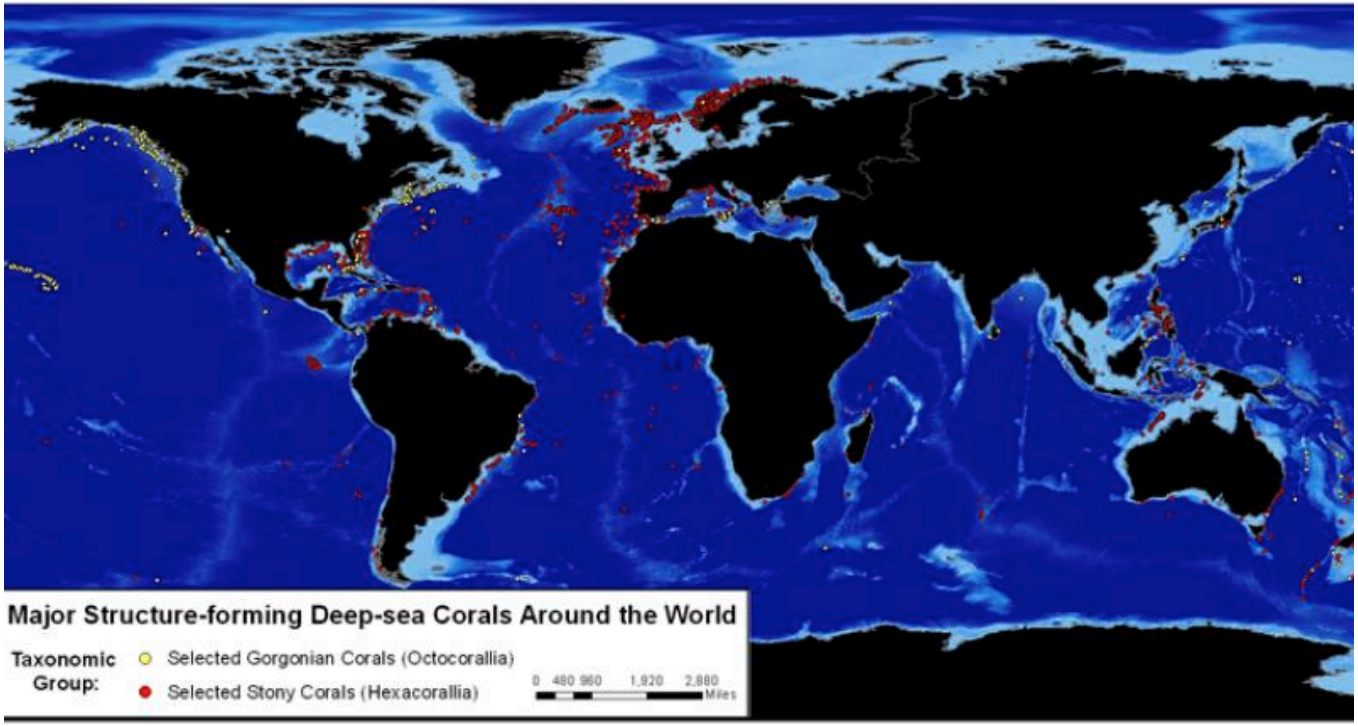
Coral Reefs
By Isabella and Connie

Global Distribution of Zooxanthellate Corals



Zooxanthellate corals are restricted to tropical and sub-tropical zones, typically between 30° north and 30° south latitudes.

Global Distribution of Deep-Sea Corals



Deep-sea corals flourish all over the world's oceans, even in Antarctica. They may grow in ocean basins, in ocean canyons, and on tall seamounts.

Elevational Distribution and General Climate

- The high photic demand of zooxanthellate corals restricts them to the euphotic zone, to a maximum of 70 metres below sea level
- Grow optimally in ocean temperatures between 23 and 29 ℃, to a maximum of 40 ℃ for short periods of time
- Also require low turbidity and high saline water - 32 to 42 parts per thousand
- Deep-sea corals do not require sunlight and may exist up to 6,000 metres below the surface, in waters as cold as -1℃
- Do not require low turbidity water, as they do not photosynthesize

Structural Features

Three types of zooxanthellate reefs:

1. Fringing - grows seaward directly from the shore
    a. Form borders along shoreline and surrounding islands
2. Atolls - formed when a fringing reef grows upward from a submerged volcanic island
    a. Circular or oval in shape, with a lagoon in the centre
3. Barrier - border a shoreline, separated by land by an expanse of water
    a. Creates a lagoon between the reef and the shore

Three Types of Zooxanthellate Coral Reefs

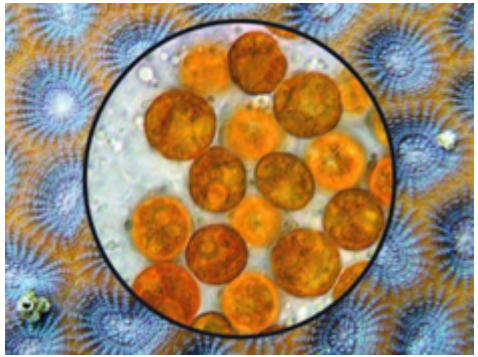
Fringing Reef

Atoll

Barrier Reef

Key Vegetation of Shallow-Water Reefs

- Corals are a symbiotic relationship between coral polyps and single-celled algae known as zooxanthellae
  - Algae provides nutrients in return for protection
- Seagrass also are a keystone species for shallow-water reefs
  - Provide shelter for small animals
  - Prevent erosion of seabed
  - Filter sediment



Characteristic and Flagship Species/Biotic Relations

- Characteristic species:
  - Fish, lobsters, clams, seahorses, sponges, sea turtles, worms, sea stars, mollusks, sea grasses, algae
- Flagship species:
  - Coral polyps and algae: form the protective structure of the coral reef
  - Sharks: exert top-down regulation on carnivorous fish, which in turn control herbivorous fish
  - Parrotfish: eat seaweed that would otherwise smother corals
- Biotic relations:
  - Coral polpys and algae
  - Anemones and clownfish
  - Parrotfish and golden-lined rabbitfish
  - Manta ray and remora
  - Christmas tree worm and coral

Biotic Relations

Remora latch onto manta rays, feeding on leftovers from a manta's meal

Parrotfish swing among rabbitfish for protection against predators. Rabbitfish have fin spines equipped with venom glands to deter predators

Christmas tree worms make their homes in coral

The clown fish protects the anemone from its predators (like butterfly fish) and the clownfish finds safety when surrounded by the stinging tentacles of the anemone

Species Richness and Endemism

- Estimated 830,000 (550,000-1,300,00) species living in coral reefs worldwide
- Highest biodiversity of any ecosystem
- Home to more than ¼ of marine life
- High levels of endemism in coral reef fishes - up to 25% for one island
    - Highest incidences (>15%) in the Malay Peninsula/Indonesia/Philippines, Red Sea, Mascarene Islands, Madagascar/Comores Islands, Society Islands, and Hawaiian Islands
- Examples: kole tang, millet butterflyfish, saddle wrasse

Anthropogenic Pressures

- Water pollution/run-off
- Sediment pollution
- Overfishing/destructive fishing practices
- Climate change
- Ocean acidification
- Ship groundings
- Recreational scuba diving

Coral Bleaching

Major Protected Areas

- 27% of coral reefs are in marine protected areas
  - Only 15% are considered effective protected areas
- Some are considered World Heritage sites: Belize's Barrier reef, Chagos archipelago, Sian Ka'an, the Galapagos islands, Great Barrier Reef, Henderson Island, Palau and Papahānaumokuākea Marine National Monument
- The Great Barrier Reef is protected by the Great Barrier Reef Marine Park

Belize Barrier reef photographed from the international space station

Sources

- https://oceanservice.noaa.gov/education/kits/corals/media/supp_coral05a.html
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- https://ocean.si.edu/ecosystems/coral-reefs/deep-sea-corals
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- https://www.pnas.org/content/105/Supplement_1/11474

Cloud Forests

Introduction

- Also known as tropical montane rainforests
- Characterized by:
  - persistent/frequent low-level cloud cover
  - cool temperatures,
  - high biodiversity and endemism
- Most vulnerable to climate change due to their small geographic range, high endemism and dependence on rare microclimatic envelope (Oliveiria et al., 2014)

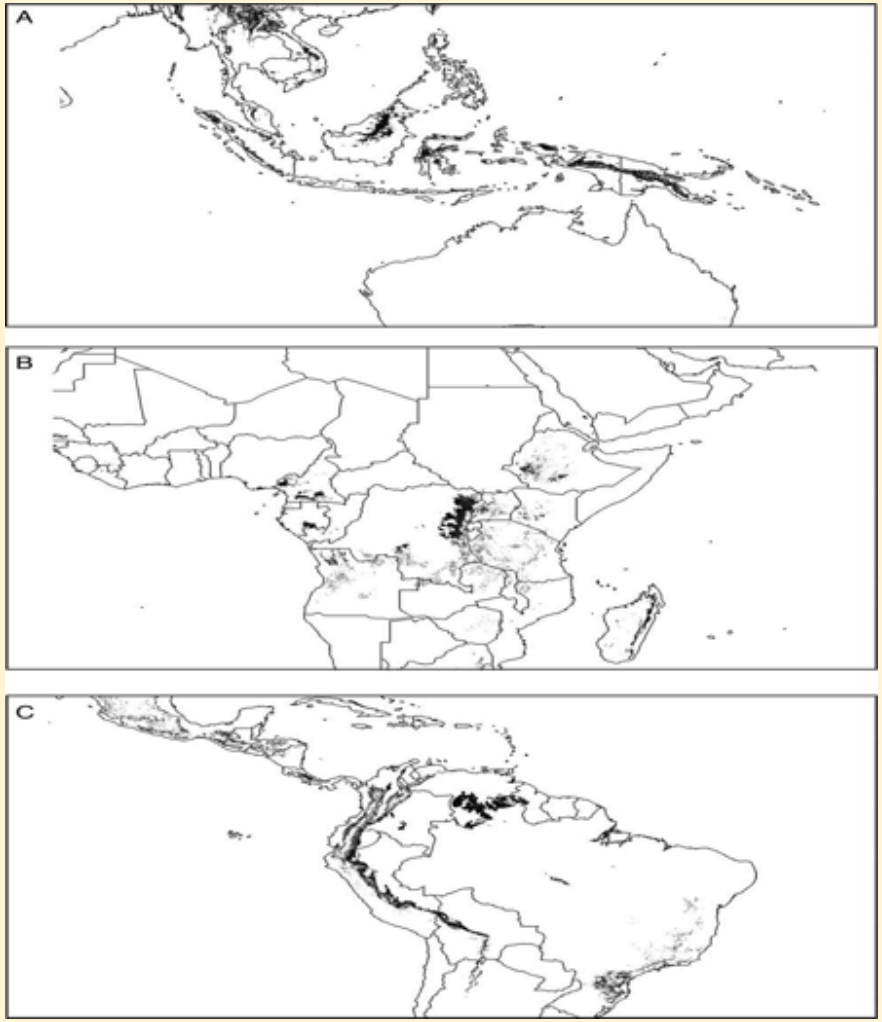
Topographical Information

- Very rare
- Covers approximately 0.14% of the entire land surface of the planet.
- Found in Central America, South America, Africa, Southeast Asia, and the Caribbean.
- There's even cloud forest on the side of Mt. Kilimanjaro in Tanzania.
- Latitude range: 23^0N to 25^0S
- Elevation range: 500 m - 4000 m from sea level

Table I.
Occurrence of cloud forests.
Total number of tropical montane cloud forest (TMCF) sites per region, with the number of sites protected.

Region	Total number of countries	Total number of TMCF sites	Total number of TMCF sites with protection
Asia	15	230	115
Africa	21	97	38
Mesoamerica / Caribbean	13	218	98
South America	6	160	76
Pacific/Oceania	4	31	n.a.
World Total	**59**	**736**	**> 327**

Source: ALDRICH *et al.*, 1997; CHAVERRI, 2001; HAMILTON, 1993



A) South-east Asia and Oceania
B) Paleotropics
C) Neotropics

Abiotic Factors

- Annual rainfall: 500 - 10,000 mm/year
- Average temperature: 8 - 20 ^{0}C
- Soil is waterlogged and acidic, forming bog-like conditions

Species Data

- Tropical montane cloud forests are not as species rich as tropical lowland forests, but they have many endemic species.
- Species richness diminishes with elevation
- The vegetation community largely comprises of mosses and ferns e.g. tree ferns are found in cloud forests

- Presence of fog reduces the amount of incoming sunlight, hence limiting productivity
  - Tree height tends to be stunted.
- Biodiversity in terms of tree species, herbs, shrubs and epiphytes can be relatively high when compared with lowland rain forests that are rich in tree species

Species Data Cont.

- Epiphytes are the richest form of life in cloud forests
- The golden toad found its habitat specifically in Monteverde, but suffered from extinction in 1987
- 21% of Monteverde’s bird species are long distance migratory birds
- Mammals of Monteverde are endemic to the region
- Species such as the mountain gorilla (Gorilla gorilla beringei) in Central/East Africa are specific to cloud forest environments

Climate Change Impact

- Lifting cloud base Hypothesis
  - Reduction in low altitude cloudiness
- Loss of species richness
- System desiccation
- Increased risk of hurricanes in the region
- Most vulnerable to climate change, due to their small geographic range, high endemism and dependence on rare microclimatic envelope (Oliveiria et al., 2014

Anthropogenic Impact

Population boom and unregulated land use contributes to cloud forest loss

In Colombia, only 10-20% of the initial cloud forest cover remains

As of 2004, ~ a third of all cloud forests were protected at that time

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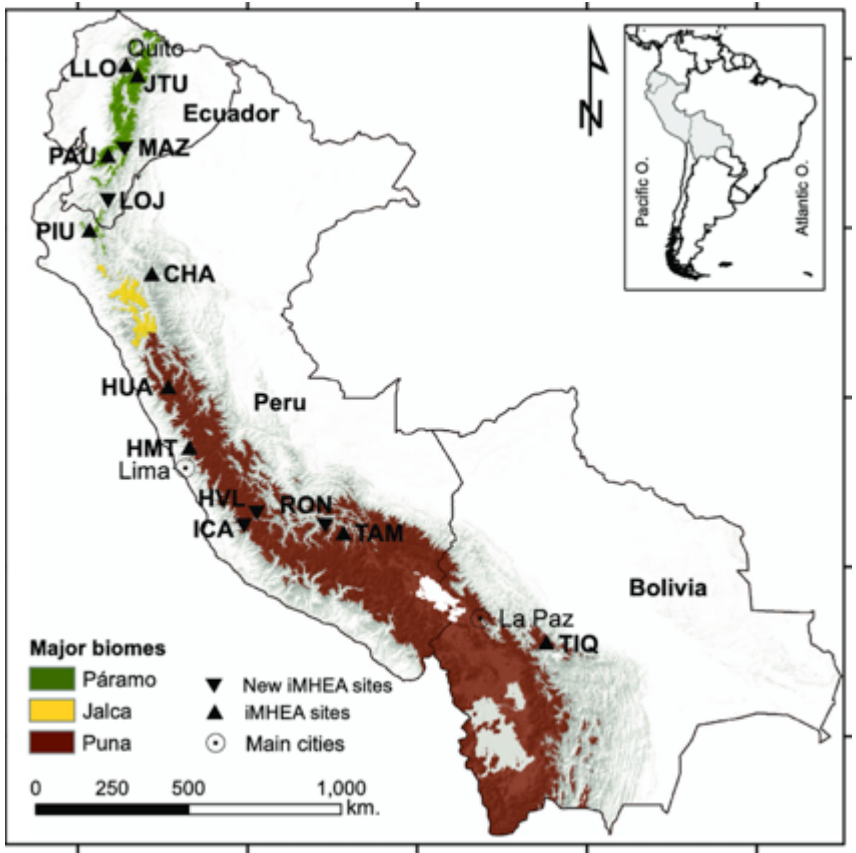
Paramo and Puna Grassland

Milly Caley, Bryce Harrison

Distribution of Paramo and Puna Grassland



Paramo, Puna and Jalca grasslands are tropical alpine ecosystems located along the Andes in South America.

The northern Andes in Venezuela, Colombia, and Ecuador receive abundant rainfall, and their alpine ecosystems are termed paramo.

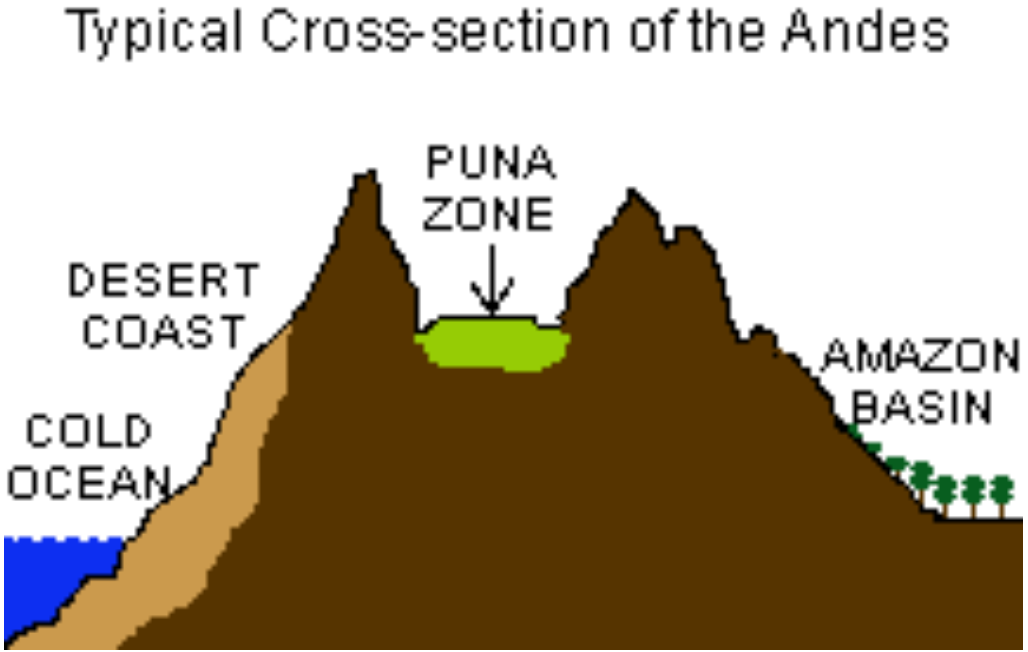
From central Peru to central Chile, the climate is drier and the alpine ecosystems are termed puna.

The transition between paramo and puna grassland occurs in northern Peru, and is termed jalca.

Their elevational distribution ranges from above the timberline (10,000 ft) to below the snow line (60,000 ft).

General climate

- 80 inches of rainfall/year
- High relative humidity of 70-80%
- Temperatures of -5 to -11°C at night and 25 - 30°C during the day.
- Snow is common, and freezing temperatures occur for the majority of the year.
- The area has high daily variability in temperatures and weather patterns.



Key species

Mammals

Endangered mountain tapir
Woodland Olfield mouse
Spectacled bear
White tailed deer
Alpacas and Llamas

Plants

Calamagrostis, Festuca, Poa and Stipa grass species
Rosetta plants
Tussock Grasses

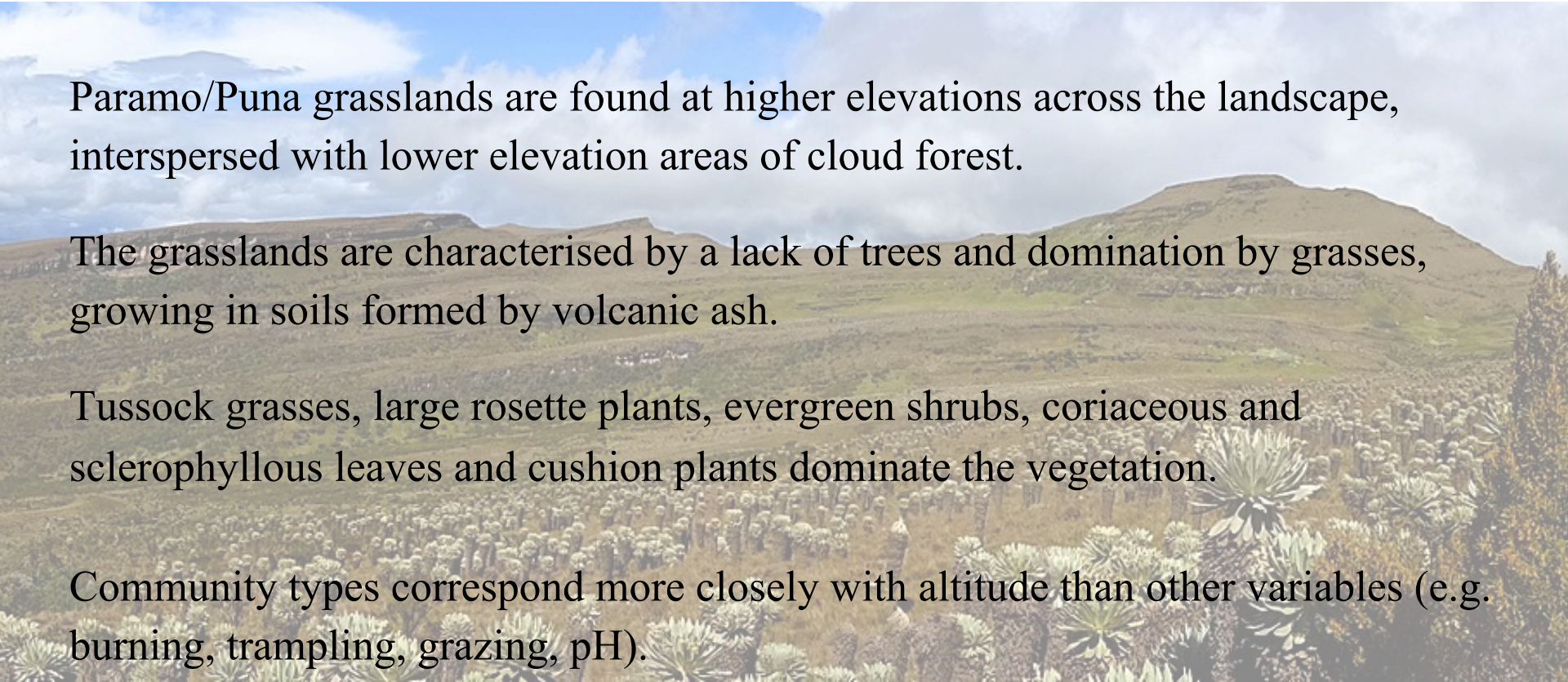
Birds

Apolinar's wren
The black-breasted puffleg
The Bogota rail
The Andean Condor

Biotic relationships

Birds and small mammals are involved in seed dispersal. Hummingbirds and bees are the main pollinators of the ecosystem.

Vegetative and Structural Features



Paramo/Puna grasslands are found at higher elevations across the landscape, interspersed with lower elevation areas of cloud forest.

The grasslands are characterised by a lack of trees and domination by grasses, growing in soils formed by volcanic ash.

Tussock grasses, large rosette plants, evergreen shrubs, coriaceous and sclerophyllous leaves and cushion plants dominate the vegetation.

Community types correspond more closely with altitude than other variables (e.g. burning, trampling, grazing, pH).

Species richness

The Paramo is has the highest plant richness in alpine tropical regions globally, with 5000 plant species spread over around 500 plant communities. There is also endemism in 60-86% of flowering plant species.

11 mammal species and 69 bird species found in the area, with some rare reptiles and frogs. The grasslands also provide important ecosystem services, providing water and regulating local climate through carbon stocking.

Non-vascular plants
36% lichens, 42 mosses, 22% hepatics

Vascular plants
10.4% ferns, 0.06% gymnosperms, 89.6% angiosperms (21% monocots, 79% dichots)

Anthropogenic pressures

The land in the Andes has been used by humans for ~15,000 years. 90-95% of forest has been cleared in the Northern Andes, which has increased the range of the grasslands.

Increasing expansion of crop production into these areas is occuring due to climate change and agricultural intensification. Construction of roads, aqueducts, increased mining, agricultural burning and livestock grazing are also contributing to ecosystem fragmentation.

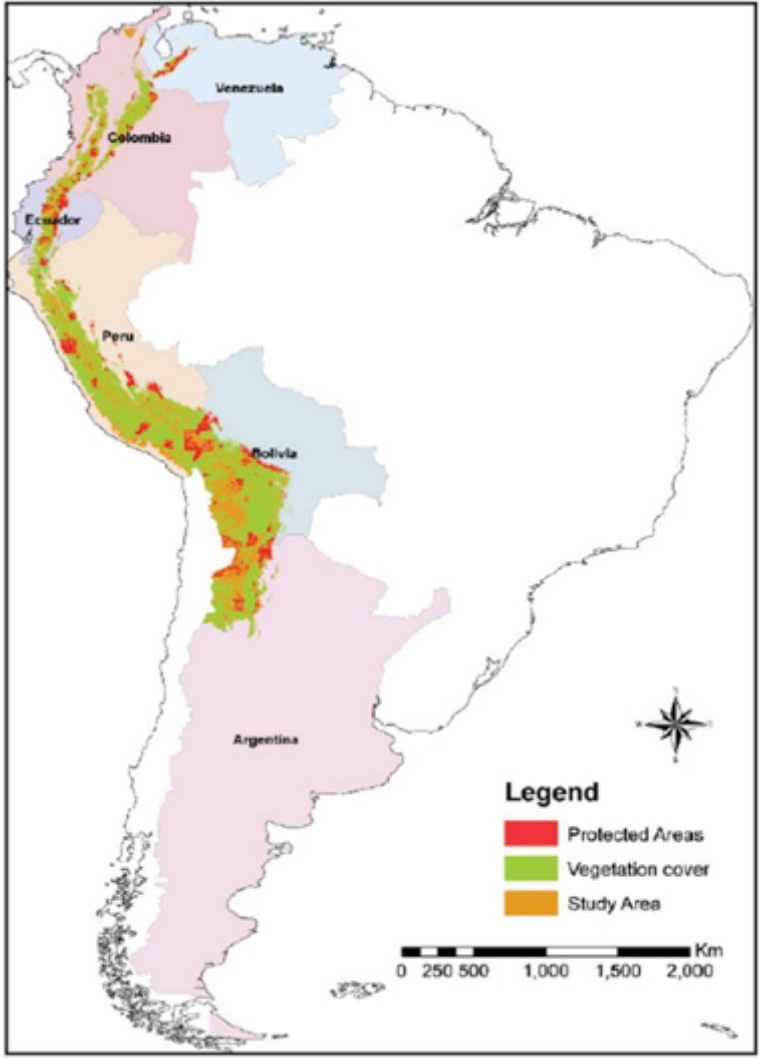
These ecosystems are particularly vulnerable to climate change due to their high endemism and restrictions to migration.

Major Protected Areas

There are numerous small protected areas located along the Andes with low connectivity and varied regulation between countries.

Some national parks in the Andes include:

- Chirripo (Costa Rica)
- Sierra Nevada de Merida (Venezuela)
- Podacarpus (Ecquador)
- Rio Abiseo Watershed (Peru)



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