Environmental systems and societies

Standard Level

Paper 1 – Mock Examination

Mock Exam 1

Calculator required

Time allowed: **1 hour**

Maximum mark: **35 marks**

Candidate information

Candidate name: .....

Session number: .....

Date: .....

Instructions to candidates

- Write your session number in the box above.
- Do not open this examination paper until you are told to do so.
- Answer **all** questions. Refer to the resource booklet that accompanies this question paper.
- Answers must be written within the answer boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[35 marks]**.

Case study: Madagascar. The resource booklet contains Figures 1–11. Some questions require more than one figure, and the final question requires the booklet as a whole. This is an original practice paper written by IB Demystified for revision purposes. It is not a past paper and is not endorsed by, affiliated with or produced by the International Baccalaureate Organization.

Answer **all** questions. Answers must be written within the answer boxes provided.

1. Using **Figure 2**, identify the ecosystem in which Ranomafana is found. [**1**]

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2. (a) Using **Figure 4**, calculate the difference between the biocapacity per person and the ecological footprint per person in 1990. [**1**]

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(b) **Figure 4** shows that Madagascar's ecological footprint per person now exceeds its biocapacity per person. Suggest **two** ways in which Madagascar could reduce this ecological deficit. [**2**]

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3. (a) Using the data in **Figure 5**, calculate the percentage of vascular plant species that are endemic to Madagascar. [**1**]

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(b) Explain why Madagascar supports a high level of endemism. [**3**]

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4. (a) With reference to **Figure 6(a)**, suggest **one** advantage of using the proposed southern route (Route B) compared with the route that was built (Route A). [**1**]

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(b) With reference to **Figure 6(a)**, suggest a possible reason why Route B was rejected in favour of Route A. [**1**]

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(c) With reference to **Figure 6(b)**, identify **one** conflict between the Ambatovy project and sustainability. [**1**]

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(d) With reference to **one** specific event in **Figure 6(b)**, outline a strategy that could be used to reduce future incidents of pollution. [**1**]

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5. With reference to **Figures 7(a)** and **7(b)**, outline **two** reasons for the change in the use of hydropower between 1990 and 2023. [**2**]

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6. Using **Figure 8**, identify which product makes up the greatest proportion of Madagascar's exports by value. [**1**]

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7. (a) With reference to **Figure 9(a)**, outline the general relationship between altitude and mean annual rainfall. [**1**]

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(b) Identify **one** transfer and **one** transformation in the hydrological cycle shown in **Figures 9(b)** and **9(c)**. [**2**]

Transfer: . . . . . .

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Transformation: . . . . . .

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(c) With reference to **Figures 9(b)** and **9(c)**, describe a feedback loop that could be triggered by deforestation of the eastern rainforest. [**2**]

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(d) Outline how the eastern rainforest may provide a **named** example of natural income. [**1**]

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(e) Describe **two** ways in which climate change could affect the eastern rainforest ecosystem. [**2**]

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8. (a) Outline **one** impact that a reduction in the greater bamboo lemur population may have on the food web in **Figure 10(b)**. [**1**]

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(b) With reference to **Figures 10(c)** and **10(d)**, explain how the arrival of the Asian common toad could contribute to the evolution of toxin resistance in a native predator population. [**2**]

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9. With reference to **Figure 11**, evaluate the potential effectiveness of the proposed southern phase of the corridor for wildlife conservation. [**3**]

10. With reference to the information in the resource booklet, discuss to what extent Madagascar has been effective at meeting its legal obligation to protect the environment. [**6**]

Please **do not** write on this page.

Answers written on this
page will not be marked.

End of examination

Total: **35 marks**

Environmental systems and societies

Standard Level

Paper 1 – resource booklet

Mock Exam 1

Calculator required

Time allowed: **1 hour**

Maximum mark: **35 marks**

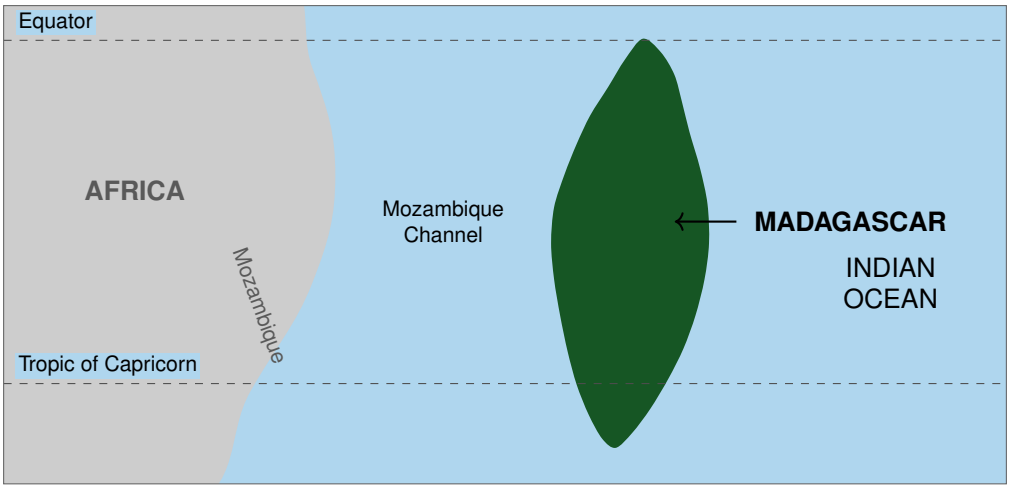
Instructions to candidates

- Do not open this booklet until you are told to do so.
- This booklet contains all the resources needed to answer paper 1.
- Case study: **Madagascar**.

Contents

Figures 1–3	Location, ecosystems and fact file on Madagascar
Figures 4–5	Ecological footprint, biocapacity and species diversity
Figure 6	The Ambatovy mine: pipeline routes and project timeline
Figures 7–8	Energy choices, electricity generation and exports
Figure 9	Rainfall, the hydrological cycle and tree adaptations
Figure 10	Ranomafana National Park, food web and an invasive species
Figure 11	Proposed protected corridor

Figure 1: Map showing the location of Madagascar



Not drawn to scale

Figure 3: Fact file on Madagascar

- Madagascar is an island covering a total area of approximately 587 000 km^2. It separated from mainland Africa around 160 million years ago and from India around 88 million years ago.
- The human population is approximately 30.3 million, and about 70 % of people live in rural areas.
- Antananarivo is the capital. Madagascar has three UNESCO World Heritage sites, one of which (the Rainforests of the Atsinanana) has been on the List of World Heritage in Danger since 2010.
- In 2015, Madagascar adopted an updated Environmental Charter, which makes protection of the environment a legal duty of the State and of every citizen, and requires an environmental impact assessment before any major development project.
- Madagascar is one of the world's biodiversity hotspots. Around 90 % of its wildlife is endemic (found nowhere else in the world), and many endemic species are listed as threatened on the IUCN Red List.
- Roughly 12 % of the land area lies inside protected areas, but many reserves have too few staff to patrol their boundaries.
- Around 11 % of the original forest cover remains. Forest is still being cleared, mainly for *tavy* (slash-and-burn rice cultivation), charcoal production and cattle pasture.
- Before 2020 there were about 375 000 international visitors each year, providing income equal to roughly 5 % of gross domestic product (GDP). The government aims to attract more nature-based tourism.

Figure 2: Ecosystems of Madagascar

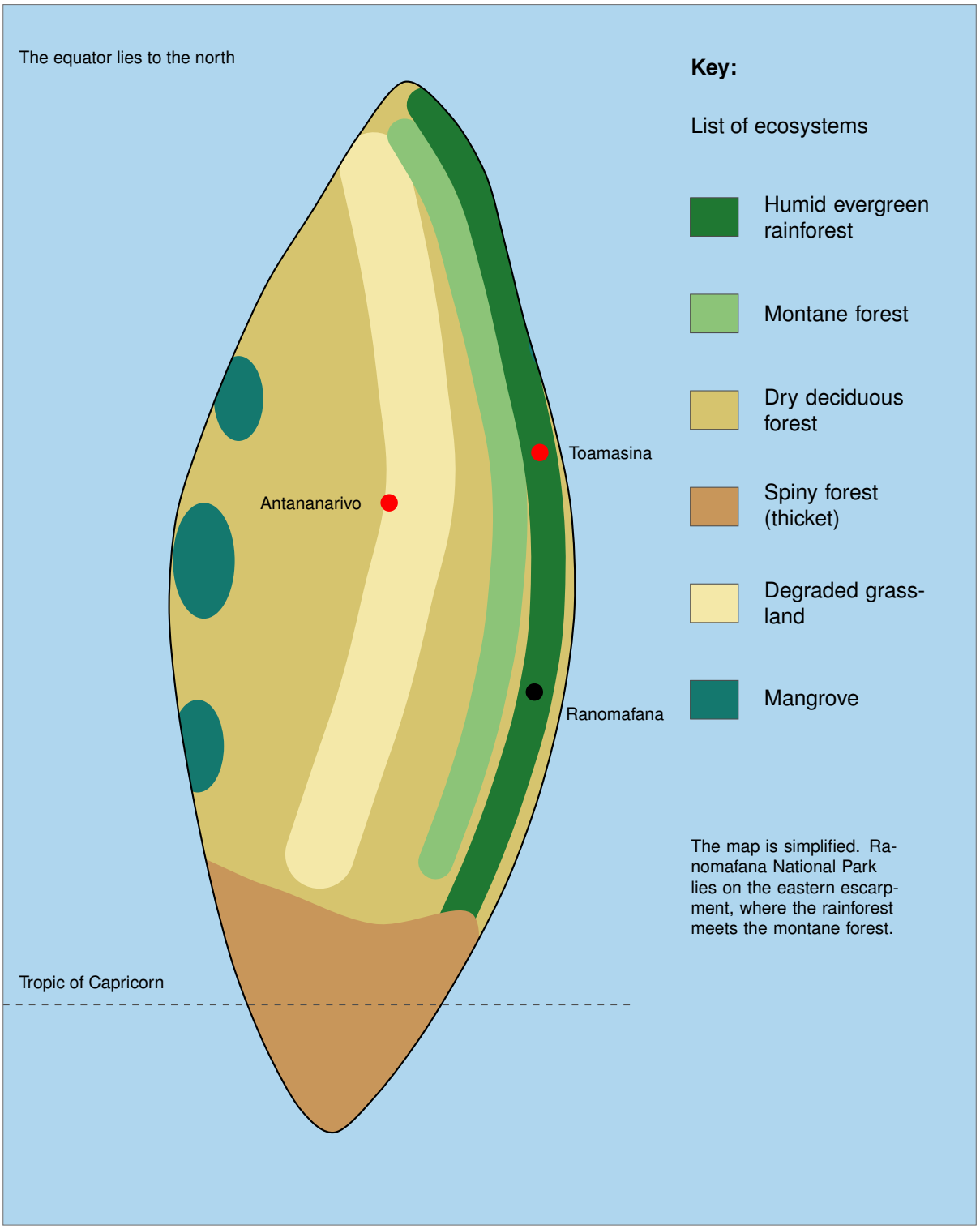
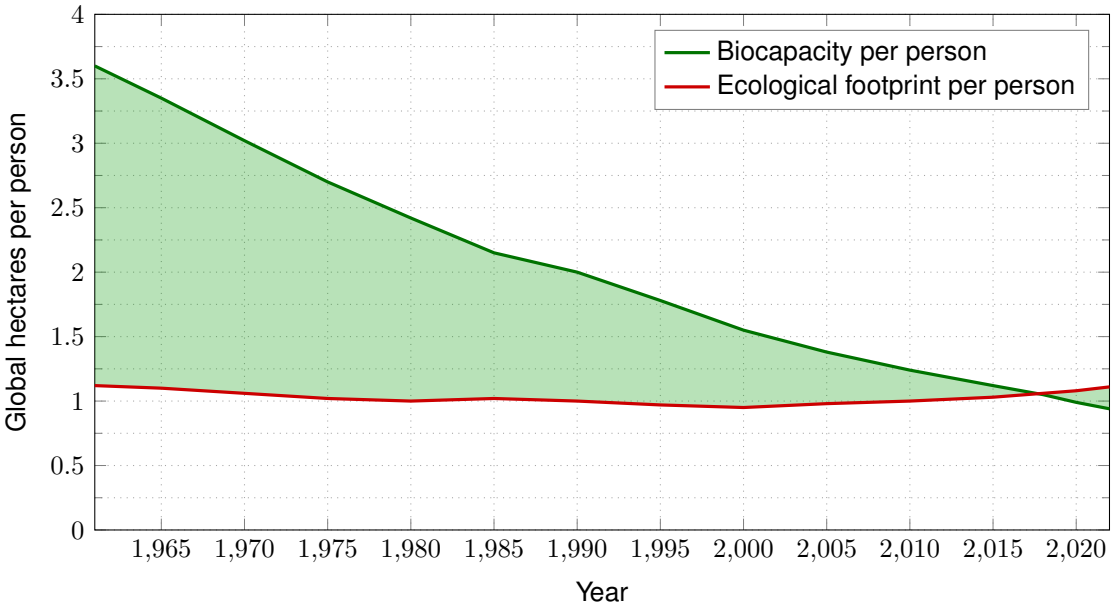


Figure 4: Ecological footprint (per person) and biocapacity (per person), 1961–2022



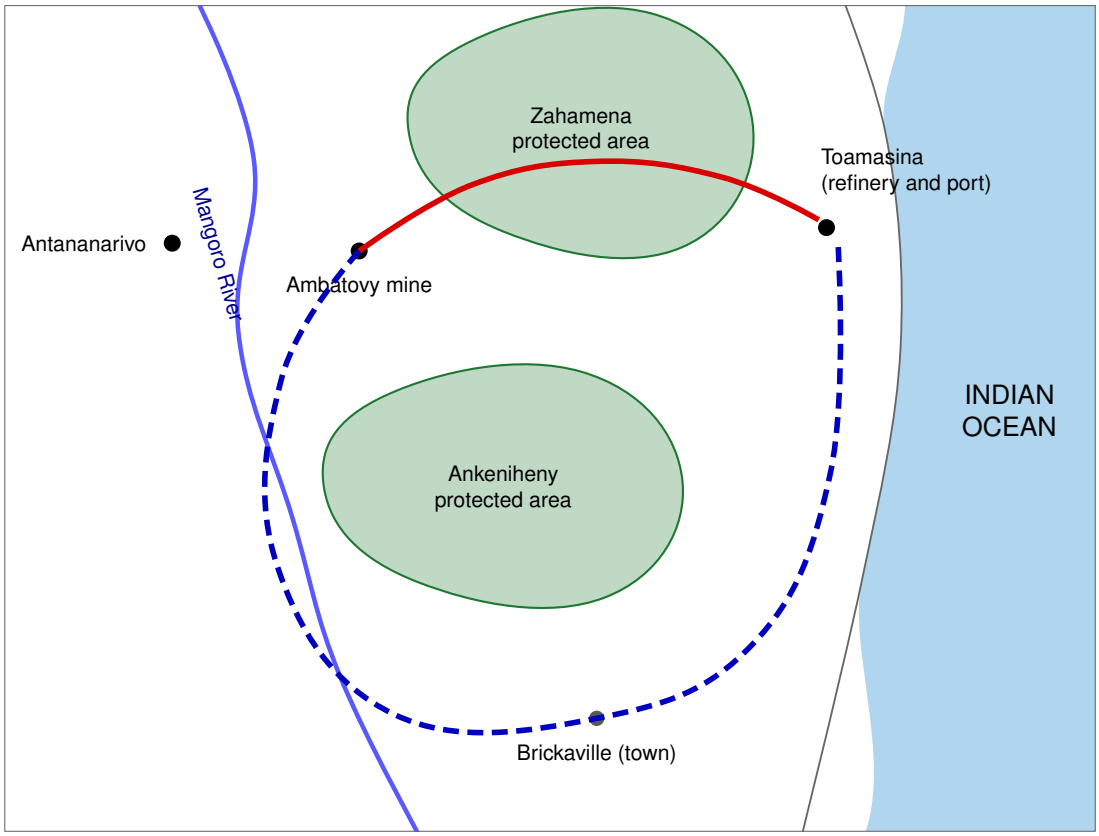
Biocapacity is the amount of biologically productive land and water available, measured in global hectares per person.

Figure 5: Species diversity among different taxonomic groups in Madagascar in 2020

Taxonomic group	Total species	Endemic species*
Vascular plants	11 516	9 704
Vertebrates	1 352	1 118
Mammals	219	205
Birds	293	115
Reptiles	420	386
Amphibians	313	310
Lemurs (a group of primates)	107	107

* Endemic species refers to those species only found in a given region. Lemurs are also counted within the total for mammals.

Figure 6(a): The Ambatovy mine and the two proposed slurry pipeline routes



Key:

- **Route A**: the 220 km pipeline that was built (opened 2012)
- **Route B**: the 310 km southern route that was proposed and then rejected
- Protected nature area
- River

Ore is mixed with water at the mine and pumped as a slurry through the pipeline to the refinery at Toamasina. The mine and pipeline are owned by an international company; the port, roads and railway are operated by the state.

Figure 6(b): Timeline for the Ambatovy nickel and cobalt project

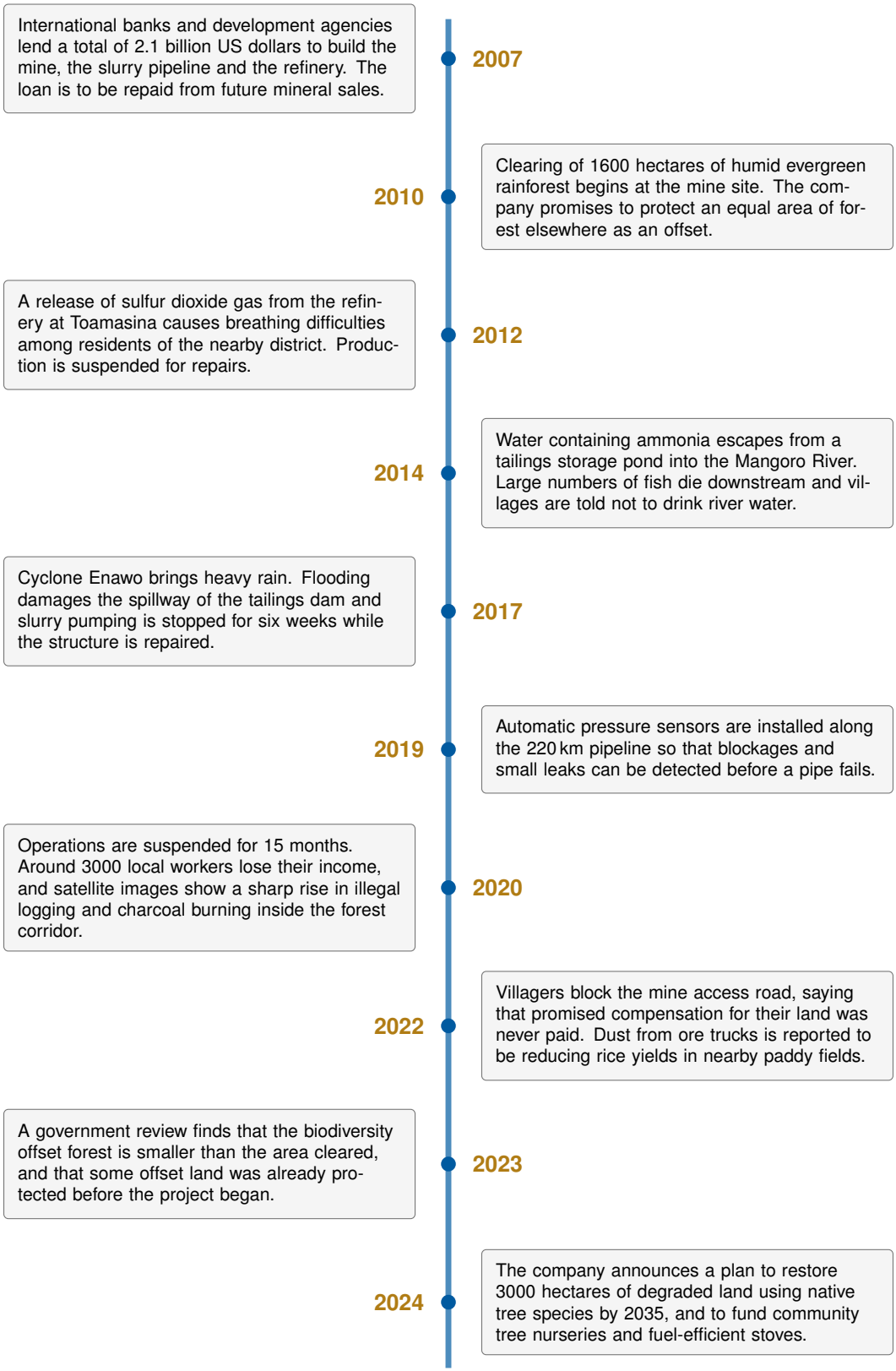
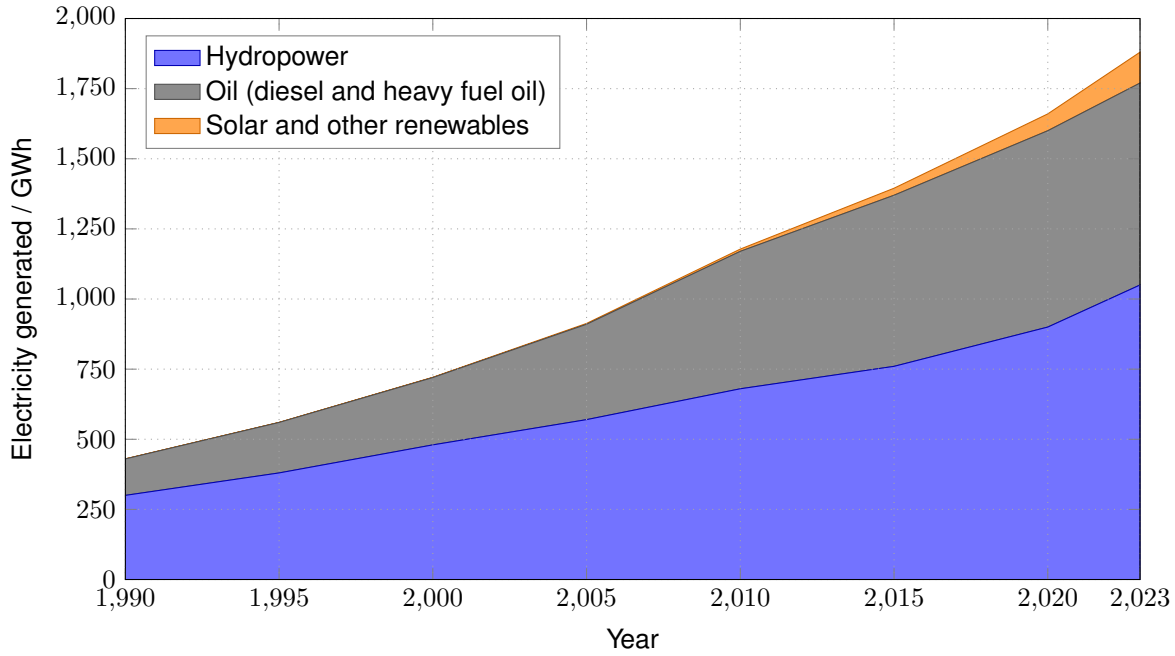


Figure 7(a): Fact file on Madagascar's energy choices

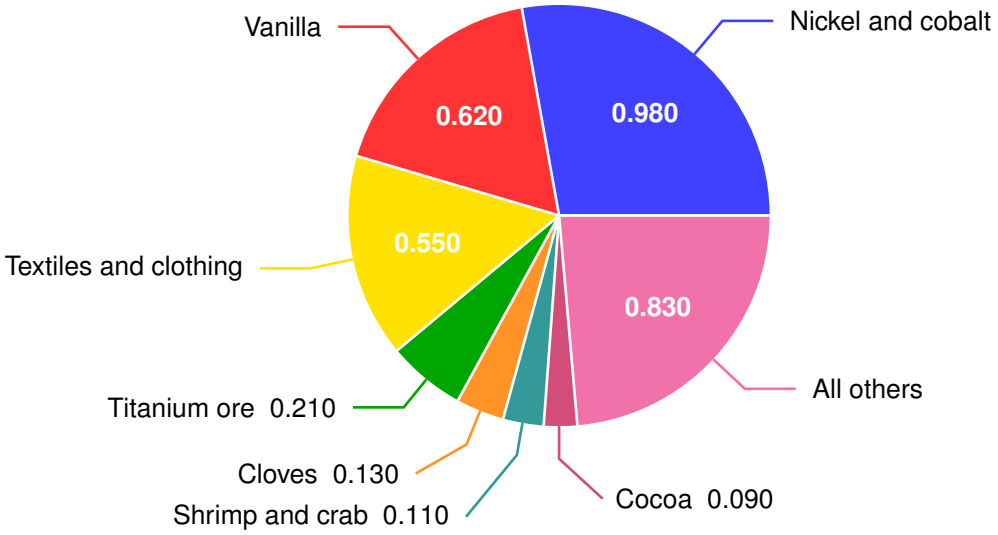
- Only about 36 % of the population has access to mains electricity. In rural areas the figure is below 15 %.
- More than 80 % of all household energy comes from fuelwood and charcoal. Charcoal production for the cities is a major cause of deforestation.
- Madagascar's mountainous interior and large rivers allow hydropower generation, but output falls during the dry season and dams can be damaged by cyclones.
- When hydropower output is low, the national grid relies on imported diesel and heavy fuel oil burned in generators, which is expensive and produces air pollution.
- Since 2015 the government and international donors have funded new hydropower dams, small solar farms and a programme distributing fuel-efficient cookstoves to rural households.
- Madagascar has signed international climate agreements and has committed to increasing the share of renewable energy in its electricity supply.

Figure 7(b): Madagascar's electricity generation by source (1990–2023)



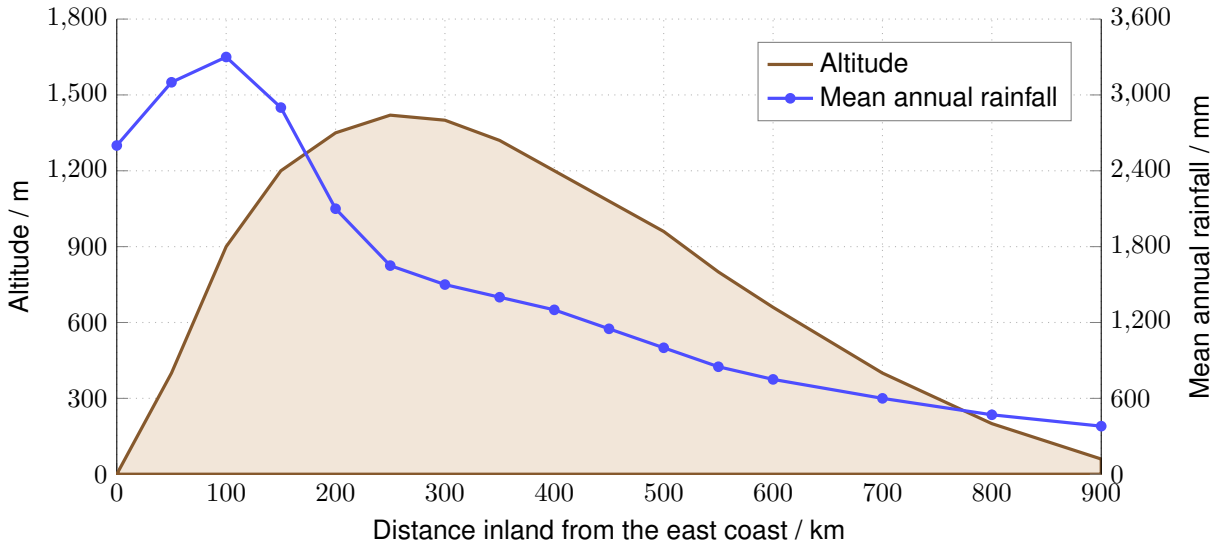
The graph is stacked: the thickness of each band shows the contribution of that source, and the top of the shaded area shows total generation.

Figure 8: Madagascar's main exports by value (billions of USD) for 2022



*Each wedge represents billions of US dollars. Total exports in 2022 were 3.52 billion US dollars.

Figure 9(a): Altitude and mean annual rainfall along an east–west transect across Madagascar



The transect runs westwards from the east coast, up the eastern escarpment and across the central highlands towards the west coast.

Figure 9(b): Relationship of the eastern rainforest with the hydrological cycle

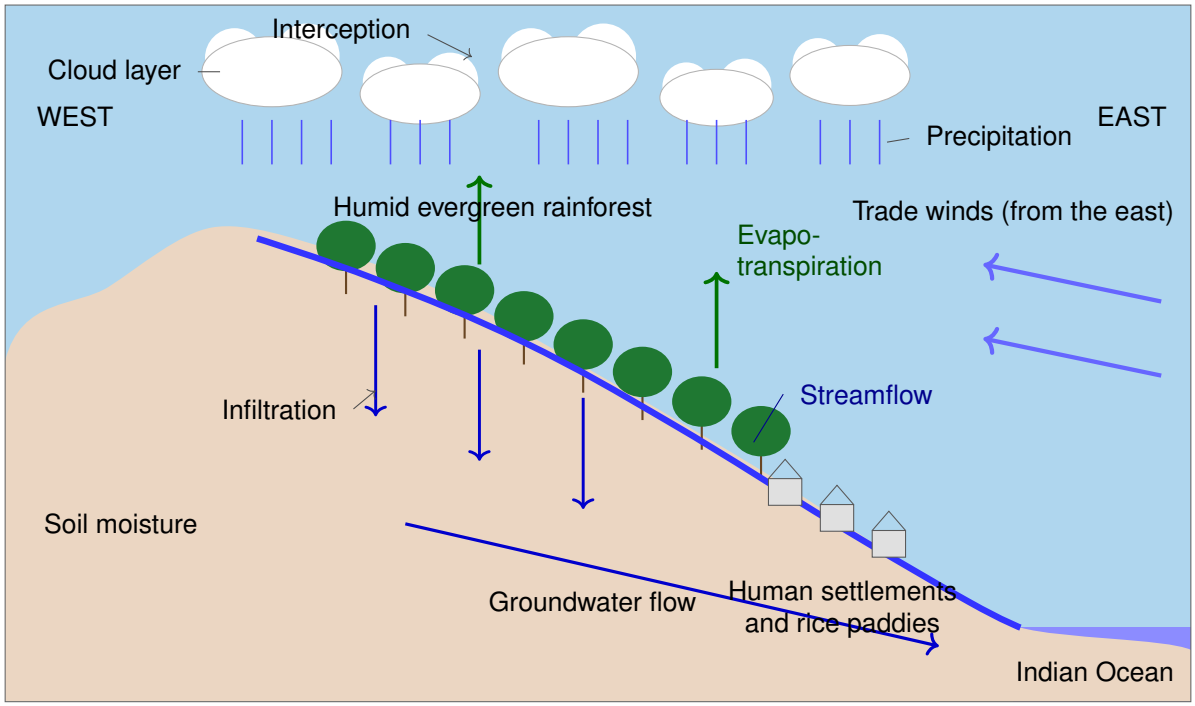


Figure 9(c): Adaptations of eastern rainforest trees

Trees in Madagascar's eastern rainforest have several adaptations that are important for their survival on steep slopes with heavy rainfall and thin, nutrient-poor soils. These adaptations include:

- **Buttress roots**: wide, flattened roots spread out from the base of the trunk. They support tall trees in shallow soil and hold soil particles in place on steep slopes, reducing erosion during heavy rain.
- **Drip tips**: many leaves end in a narrow point, which allows rainwater to run off the leaf quickly. This prevents algae and fungi growing on the leaf surface and reduces damage to the leaf.
- **Shallow root mats and mycorrhizal fungi**: a dense mat of fine roots just below the surface, together with fungi living on the roots, takes up nutrients released by decomposing leaf litter before they are washed away by rainfall.
- **Dense, layered canopy**: the crowns of the trees intercept a large proportion of the rainfall. Some of this water evaporates directly back to the atmosphere, and the rest reaches the ground slowly, allowing more time for infiltration.

Figure 10(a): Fact file on Ranomafana National Park

- Ranomafana National Park was established in 1991 and covers 416 km^2 of humid evergreen rainforest on the eastern escarpment.
- It forms part of the Rainforests of the Atsinanana UNESCO World Heritage site, which was placed on the List of World Heritage in Danger in 2010 following illegal logging of rosewood.
- The park protects 12 species of lemur, including the critically endangered greater bamboo lemur, which feeds almost entirely on one species of giant bamboo.
- Around 30 000 people live in villages within 5 km of the park boundary. Most depend on rice grown using *tavy* (slash-and-burn), in which forest is cleared and burned, cropped for two or three years and then left to recover.
- Conservation organizations are working with these communities to develop shade-grown vanilla and coffee, fish ponds and improved rice terraces as alternatives to *tavy*, and to train local people as guides.
- Park entrance fees are shared with surrounding communities, but visitor numbers fell sharply between 2020 and 2022 and have not fully recovered.

Figure 10(b): Simplified food web for the eastern rainforest of Madagascar

Arrows show the direction of energy flow. The width of the shaded triangle represents the decrease in biomass at each trophic level.

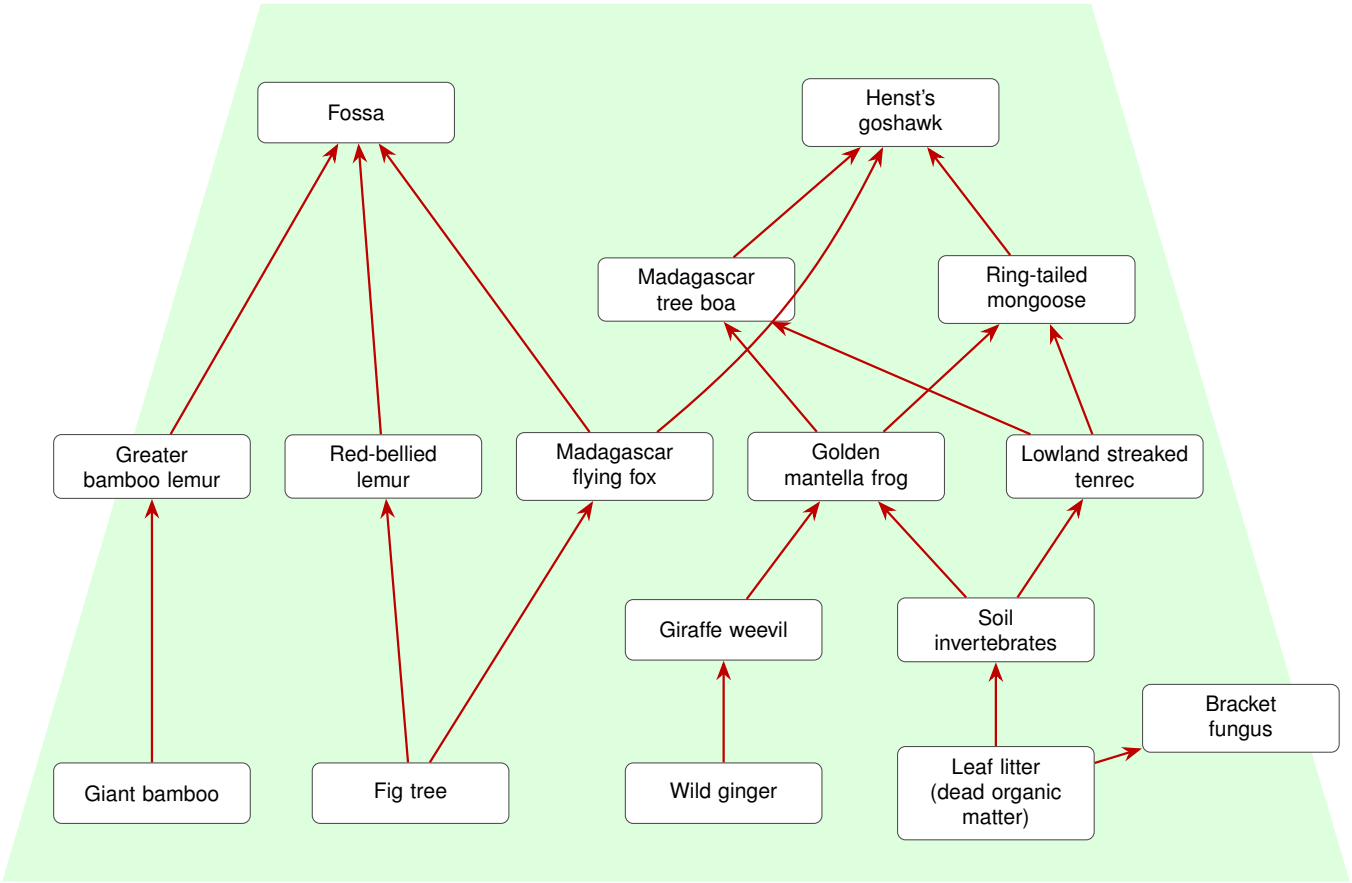
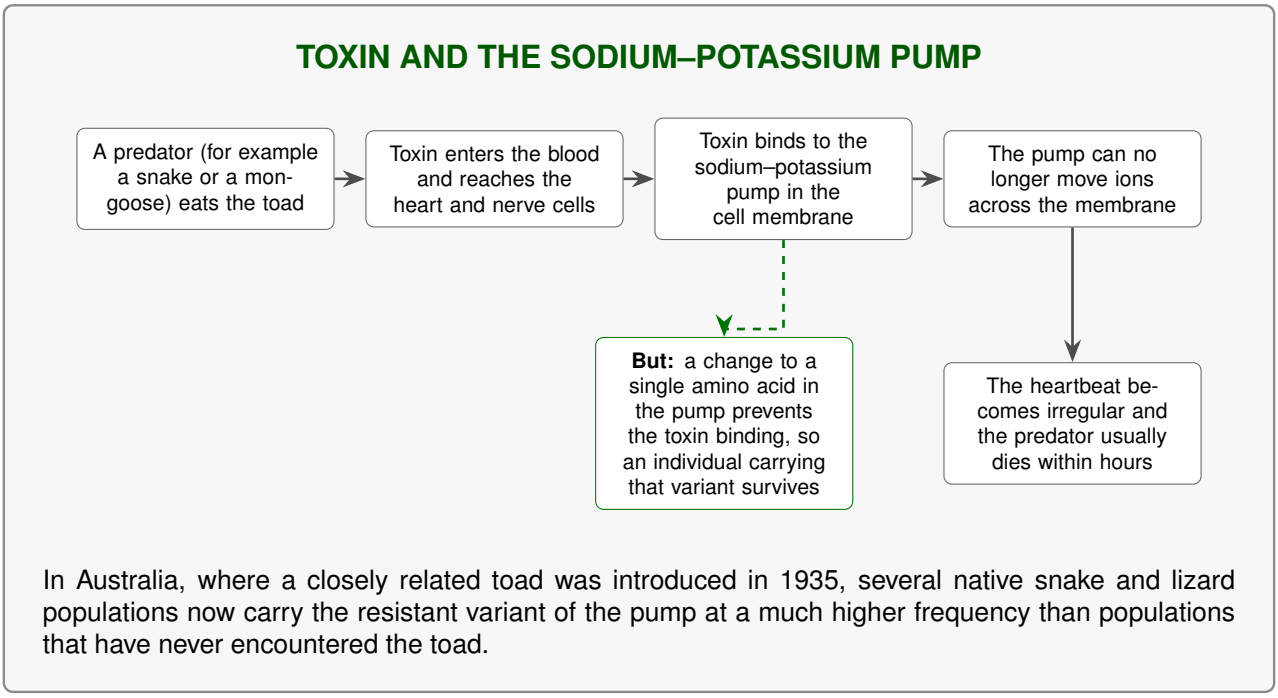


Figure 10(c): Fact file on the Asian common toad, an invasive species in Madagascar

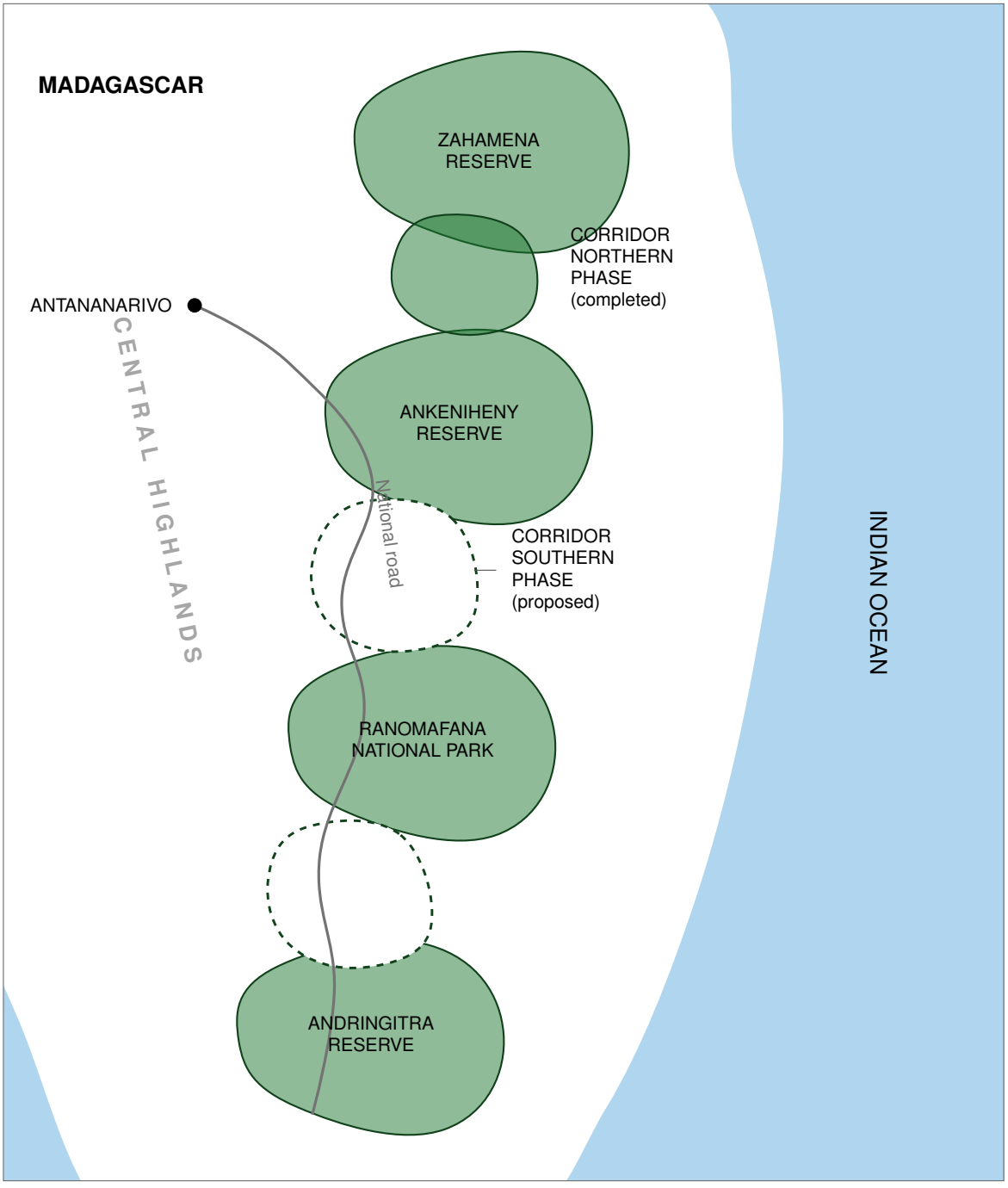
- The Asian common toad was first recorded near the port of Toamasina in 2010. It probably arrived in shipping containers linked to the mining project.
- It has since spread across more than 500 km^2 and continues to move inland along roads, railway lines and river valleys.
- Glands in its skin contain powerful toxins. Almost all Malagasy predators that have been tested lack the genetic variant that would allow them to survive eating the toad.
- It competes with Madagascar's endemic frogs for food and breeding sites, and it can carry the chytrid fungus, a pathogen linked to amphibian declines worldwide.
- A scientific review concluded that eradication would be extremely expensive and is now very unlikely to succeed. Management has therefore shifted to containment, hand-collection at the invasion front and public awareness campaigns.
- Madagascar's endemic amphibians are also threatened by habitat loss, collection for the international pet trade and pesticide pollution from rice cultivation.

Figure 10(d): Mechanism by which the toad's toxin kills native predators



In Australia, where a closely related toad was introduced in 1935, several native snake and lizard populations now carry the resistant variant of the pump at a much higher frequency than populations that have never encountered the toad.

Figure 11: Proposal for a protected corridor connecting Ranomafana National Park with other reserves



Note on sources

This resource booklet was written and drawn by IB Demystified as original practice material. It is not a past paper, and it is not endorsed by, affiliated with or produced by the International Baccalaureate Organization.

The Madagascar case study is realistic but deliberately simplified for teaching. All figures have been drawn for this paper. Values have been rounded so that they can be read quickly under exam conditions, and some events in the timeline in Figure 6(b) have been simplified or combined. The species shown in the food web in Figure 10(b) do occur in Madagascar's eastern rainforest, but the feeding relationships shown are a simplified selection rather than a complete web. None of the values in this booklet should be quoted as a research source.

Background for the case study was drawn from publicly available material on Madagascar's biodiversity, protected-area network, energy mix and export profile, and from published research on invasive toads and toxin resistance in predators. Students who need accurate current figures should consult the original data providers directly.

End of resource booklet
