EASTERN AND
SOUTHERN AFRICA

Madagascar CCDR

Background Note
Blue Economy for Madagascar

World Bank Group

COUNTRY CLIMATE AND DEVELOPMENT REPORT

November 2024

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INTRODUCTION

1. Madagascar, the world's fourth-largest island country, is home to abundant marine and coastal resources. Its coastline is the longest in Africa, and its 587,000 km2 land area generates an exclusive economic zone (EEZ) more than twice as large (1.2 million km2). Within this extensive EEZ are the resources that form the foundation of a large portion of the Malagasy economy. It is estimated that fisheries account for approximately 7 percent of gross domestic product, and rich natural capital of mangroves, coral reefs, and seagrasses generates ecosystem services.

2. More than 250,000 hectares of mangroves on the west coast provide fish nurseries, carbon storage, coastal protection, and timber, and close to half a million hectares of coral reefs in the west, northwest, and northeast and inshore coastal areas host a great diversity of fish resources important to coastal communities (World Bank 2023).

3. These coastal areas merit particular attention because of their vulnerability to the effects of climate change. Incidence of poverty in the coastal zone is markedly higher than in inland areas, as is the incidence of food insecurity in communities that depend upon ocean resources. The impacts of climate change—including sea level rise, coastal erosion, and resource degradation—will exacerbate these already pressing challenges.

4. Understanding the relationship between climate change and the Malagasy ocean economy is therefore of particular importance. Although the country's marine natural capital has the potential to drive climate change adaptation through climate-aware marine spatial planning and innovative finance, these resources are uniquely vulnerable to the effects of climate change through increases in sea temperature, sea level rise, coral bleaching, and ocean acidification. Likewise, important carbon sinks such as mangroves, seagrass beds, and coastal sediment must be protected to avoid the potentially catastrophic release of stored carbon and to provide opportunities to bring blue carbon credits to market.

5. Making optimal use of Madagascar's marine natural capital requires comprehensive understanding of oceanic economic activity, interactions between oceanic sectors, and tradeoffs between adaptation and mitigation investments in oceanic sectors.

6. Adopting a blue economy approach—an approach that considers the sustainable, integrated development of economic sectors in healthy oceans—places these interactions at the forefront of development and will enable Madagascar to make the most of its marine natural capital and reduce the impacts of climate change across the economy.

7. Ensuring that the full potential of oceans becomes a source of resilience and growth in Madagascar therefore depends on adoption of a blue economy approach to assessing the impacts of climate change and the opportunities of greater investment.

Applying the Blue Economy in Madagascar

8. The World Bank defines the blue economy as the sustainable and integrated development of economic sectors in healthy oceans. A blue economy approach therefore considers how best to use natural capital for sustainable growth in the long term by integrating ocean sectors, explicitly considering spillover effects, and considering current and future climate risk.

9. Because many of the oceanic sectors in Madagascar are nascent, a blue economy approach can guide future investment in areas such as tourism, energy, and transport without disrupting established economic activities (e.g., fisheries) and natural assets (e.g., mangroves and seagrasses). By including expectations of how economic activities will perform and how ecosystem health will change as climate change progresses, a blue economy approach can anticipate the impacts of climate change and help address long-term risk.

10. Building a successful blue economy approach in Madagascar depends upon four interconnected streams around which this section is structured: First, Madagascar must create the capacity for integrated planning in oceanic sectors through marine spatial planning and a national blue economy strategy (Table 1). Second, the needs and impacts of each sector of significance must be identified and considered in the context of integrated planning. Third, innovative use of nature-based solutions and infrastructure for development and climate resilience should be assessed and accounted for. Finally, innovative financing arising from nature-based solutions, carbon sequestration and storage, and economic activities in protected areas must be identified.

Table 1. Blue Economy Priority Climate Resilience Capacity Development, Reform Needs, and Recommendations

Action	Prerequisite reforms (what is required to implement recommended action)	Cost estimate (USD/year)	Recommendation
Quick wins (priority investments that can be implemented by 2025)			
Implement comprehensive marine spatial planning initiative.	Ensure national and local political commitment Commit sufficient financial resources and ensure meaningful stakeholder consultations and engagement.	500,000 for 18-24 months	Ensure that all relevant private sector constituents are represented, including coastal tourism investors and fish processors, even when destructive activities are involved (e.g., sand mining).
Continue to support growing network of marine protected areas	Identify and protect marine protected areas. Identify possible financial flow generation. Encourage meaningful participation by local communities.	500,000 for 2-5 years	Ensure that tourism operators pay for marine protected areas that protect the blue capital on which their business models are built.
Mid- to longer-term actions (priority investments that can be implemented by 2030 and 2050)			
Implement enhanced, sustained fisheries reform, focused on sustainability, including by addressing hidden fish subsidies.	Prevent interference from foreign investors encouraging greater catch volume rather than increasing the value of what is caught.	500,000 for 1-10 years	Identify and reward private sector investors focused on quality rather than quantity.
Develop Madagascar's shipping sector with a focus on sustainability and protection of ocean health (e.g., decarbonization, ship pollution abatement).	Create strong regulatory framework that builds favorable investment climate for the sector (ports and ships).	200,000	Engage with large shipping conglomerates through ongoing International Maritime Organization initiatives on decarbonization.

Country Context

11. Madagascar has an extensive coastline and an unusually large inland area for an island country. Fifty-nine percent of the country's land area is considered coastal—defined as the land area within 100 km of the coastline—but only 38 percent of the population lives in coastal areas.[1]

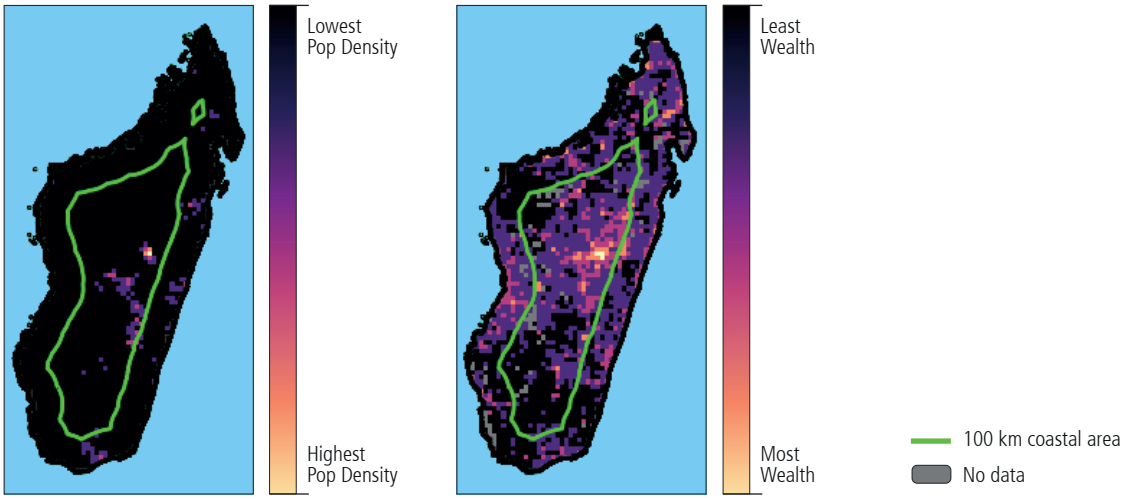
1 Author calculation based on population estimates from Facebook Connectivity Lab, "Connecting the World with Better Maps: Data-Assisted Population Distribution Mapping" (https://about.fb.com/wp-content/uploads/2016/02/population_density_final_mj2_ym_tt2113-1.pdf) and Center for International Earth Science Information Network, Columbia University (https://ciesin.climate.columbia.edu/).

12. This geography, alongside Madagascar's location between the Mozambique Channel and the Indian Ocean, contributes to the country's rich biodiversity and the abundance of marine resources. The island supports several ecosystems, with extensive mangrove forests, seagrass beds, coral reefs, and beaches prevalent along the coast.

13. The extensive EEZ and coastal areas house abundant resources. Madagascar is home to about 2 percent of global mangrove cover, making it one of the most mangrove-rich countries in the world. Seagrasses are thought to be abundant (coverage of 2,000–4,500 km2), but no data are available to quantify their extent accurately. It is estimated that Madagascar accounts for approximately 2 percent of global coral reef area, also a significant amount.

14. Although subnational poverty data are not readily available, wealth levels for inhabited areas of Madagascar have been estimated (Lee and Braithwaite 2022), and based on these estimates, poverty is greater (mean wealth is 7 percent higher inland than within 100 km of the coast) and more widespread (57 percent of coastal areas and 43 percent of inland areas have below-median levels of poverty) in coastal areas than inland (Map 1). Connectivity is also lower; average distance to a primary road in Madagascar is 39.1 km in coastal areas and 33.4 km in the more urban inland area.

Map 1. Wealth And Population Heatmaps



Source: Facebook Connectivity Lab , "Connecting the World with Better Maps: Data-Assisted Population Distribution Mapping" (https://about.fb.com/wp-content/uploads/2016/02/population_density_final_mj2_ym_tt2113-1.pdf); Lee and Braithwaite 2022.

15. Climate change exacerbates these vulnerabilities and creates unique challenges for coastal communities. Coastal areas are more exposed to natural disasters—especially cyclones—than inland areas. Greater incidence of natural disasters, including cyclones and drought, is associated with climate change. Climate change–induced sea level rise causes flooding and coastal erosion, which have immediate and disproportionate impacts on coastal communities. Sea level rise also contributes to saline intrusion of aquifers, which is especially prevalent in coastal areas, where wells are shallower and saline intrusion more likely.

16. Addressing vulnerability in coastal communities is an integral part of any attempt to adapt to and mitigate climate change in Madagascar. Madagascar's nationally determined contribution to the United Nations Framework Convention on Climate Change includes commitments to reinforce natural

protection and reduce the vulnerability of coastal, inshore, and offshore marine areas affected by coastal erosion and receding shorelines. The nationally determined contribution includes restoration of natural habitats, including mangroves and coastal wetlands.

Integrated Planning for the Blue Economy

17. Integrated planning of development in oceanic sectors underlies any blue economy approach to development. Marine ecosystems are uniquely interconnected, so exploitation of marine resources has unintended, unforeseen spillover effects. Preventing negative spillovers and promoting synergies depends upon careful, integrated planning to maximize value and increase resilience. Integrated planning in pursuit of a blue economy has therefore been a key recommendation of the World Bank to the government of Madagascar in previous documents, including the recent Madagascar Country Environmental Analysis (World Bank 2024).

18. One of the key outcomes of a strong, integrated planning process is a framework to unify assessment of the social, ecological, and economic benefits and impacts of investment in blue sectors. Planning processes provide certainty to investors by specifying regulations and incentives, provide the evidence base for conservation measures by identifying areas of ecological importance, and involve communities and affected residents to increase inclusiveness.

19. Well-prepared planning processes also support achievement of national and international climate commitments, protect the interests of coastal communities threatened by sea level rise, and delineate uses of marine space dedicated to climate change mitigation.

20. The tools supporting integrated planning include marine spatial plans, a national blue economy strategy, and various ad hoc analyses such as blue public expenditure and institutional reviews. Marine spatial planning provides a comprehensive, integrated investment framework by delineating use of specific areas of a country's marine space and helps quantify the economic benefits that result from natural capital assets, including the intrinsic value of the stock of natural capital and the economic flows resulting from sustainable use and ecosystem services. A blue economy approach therefore also makes an economic case for nature and provides justification for investment in oceanic sectors. Marine spatial plans should be developed subnationally, guided by an overarching framework and a national blue economy strategy.

21. Successful design and implementation of integrated planning requires strengthening the scientific and planning capacity of the government. Although Madagascar is already moving toward a blue economy approach and is committed to managing and generating more benefits from its marine and coastal resources, stronger cross-sectoral coordination and collaboration are required to realize this vision. Additional work must be done to increase stakeholder engagement, especially in the private sector, with coastal communities and with a process that ensures effective cross-sectoral interaction and involvement. Although planning processes must balance the requirements of various users of marine space, planning processes should consider ways of minimizing uneven distributional consequences and provide alternative livelihoods and compensation to affected groups. Additional scientific and analytical capacity is necessary to monitor the results of planning.

Sectoral Analysis

22. The foundations of a Malagasy blue economy lie in current and future oceanic sectors that will drive sustainable, climate-aware growth. The two key sectors that merit particular attention are fisheries and blue ecotourism. Fisheries are a well-established economic activity that requires close attention to ensure sustainability in the face of climate change. Blue ecotourism is an emerging sector that has the potential to be a driver of sustainable growth. Both depend upon integrated planning and financing to protect the resource base that they rely upon.

23. The fishery sector is one of the most important sectors in the economy, accounting for more than 7.7 percent of gross domestic product and 7 percent of exports in 2020. Fisheries are also important for the livelihoods and food security of Malagasy residents, as discussed below, although climate change is threatening scall-scale fisheries, with extreme coastal weather conditions limiting the number of days when fishermen can go out on their small pirogues and increasing sea temperatures, which affects the health and productivity of fish and fisheries in Madagascar's waters, and thereby challenging this source of growth.

24. Formal employment figures reported to the International Labour Organization in 2015, the most recent data available, show direct employment of 1.7 percent of total employment in the fisheries sector, but contemporaneous Food and Agriculture Organization of the United Nations estimates of indirect employment indicate that more than 1 million people depend upon fisheries for their livelihoods. Assuming a 10-fold employment multiplier and linear growth, more than 2,000,000 people are directly and indirectly employed in the fisheries sector, or about 6.8 percent of the population.

25. Women are relatively well represented as fishers in Madagascar, accounting for 21 percent of fishers and 13 percent of fish crew. (In most countries, women are excluded from fishing vessels.) Downstream activities, such as gleaning, processing, and sale, are also likely to employ significant numbers of women. International Labour Organization data indicate that more than 40 percent of those employed in the fisheries sector are female.

26. Fisheries are vital for Malagasy food security and nutrition. Food and Agriculture Organization of the United Nations headline nutrition data indicate that 3 percent of total protein (and 22 percent of animal-derived protein) consumed is from fish and seafood (Figure 1), although sources of nutrition vary significantly across the island, with marine fish consumption likely quite low in the highlands versus almost daily in coastal areas.[2]

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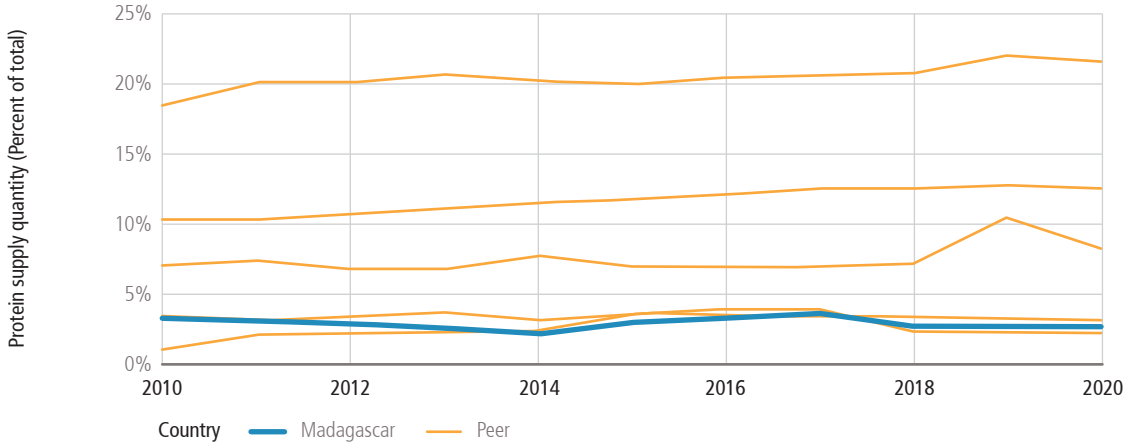
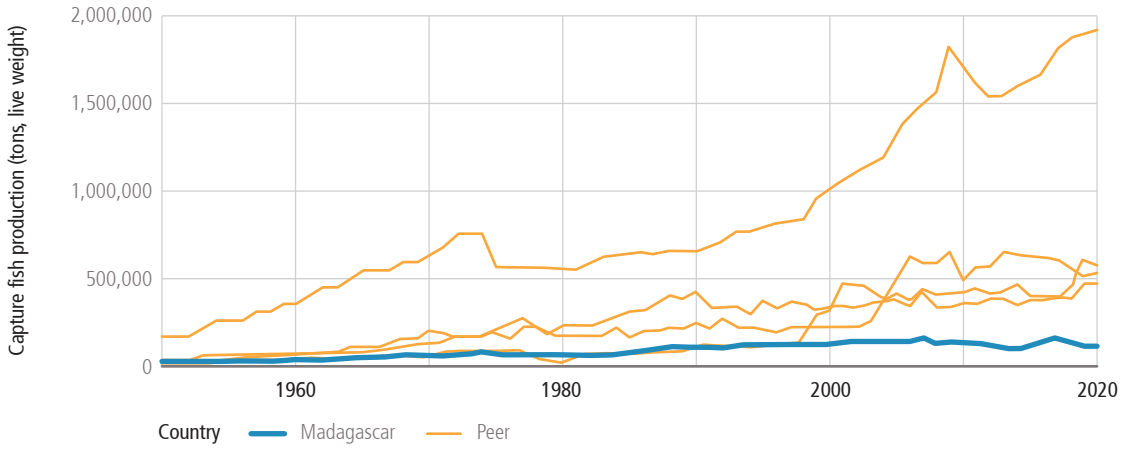
2 See, e.g., https://doi.org/10.1017/S0030605315000307.

Figure 1. Protein Consumption, Madagascar and Peer Countries



27. Madagascar capture fisheries data are highly aggregated, hindering precise understanding of the composition of catch in the country.[3] Most of the reported catch in the last five years is identified only as "marine fishes;" the second largest category is shrimp, followed by freshwater fish, cephalopods (octopus), mollusks, and crustaceans. Catches of large pelagic fish such as tuna and billfish are much smaller than in other countries in the region (Figure 2).

Figure 2. Total Capture Fishery Production, Madagascar and Peer Countries



28. Madagascar's coastal fisheries are highly stressed and almost all are considered fully fished or over-fished. Poor monitoring, control, surveillance, and resource management plan strategies inhibit regeneration of fish stocks.

29. Estimates of foreign fishing in Madagascar are unreliable. After a four-year interruption, Madagascar and the European Union agreed upon a new sustainable fisheries agreement that trades access for 65 tuna fishing vessels over four years for EUR1.8 million in annual transfers to Madagascar. There are reports that Madagascar has signed fishing access agreements with Chinese companies.

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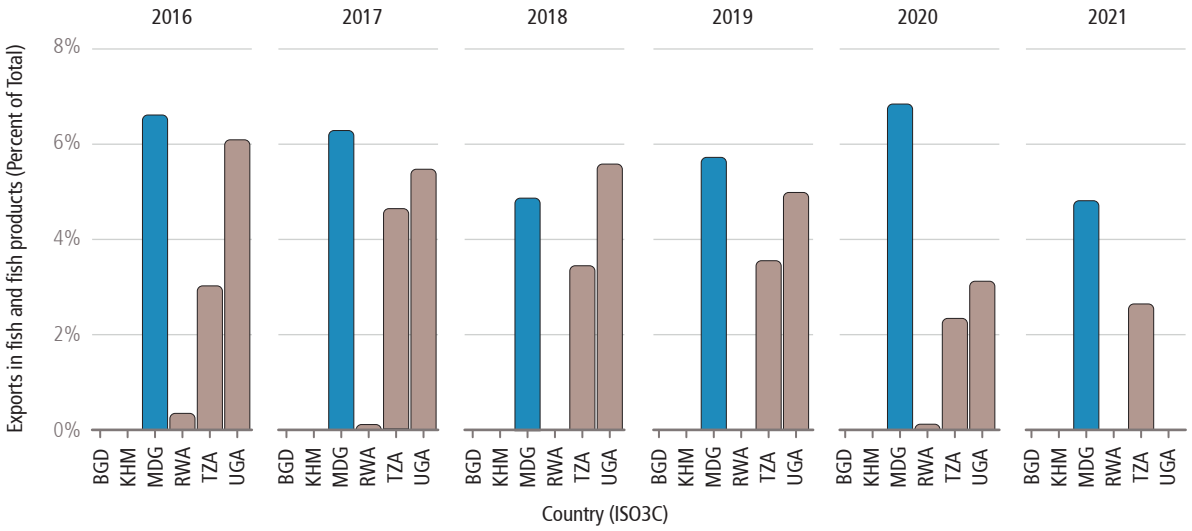
3 See Seas Around Us data (accessed 2024), https://www.seaaroundus.org/data/#/eez/450?chart=catch-chart&dimension=taxon&measure=tonnage&limit=10. FAOSTAT data are substantively similar.

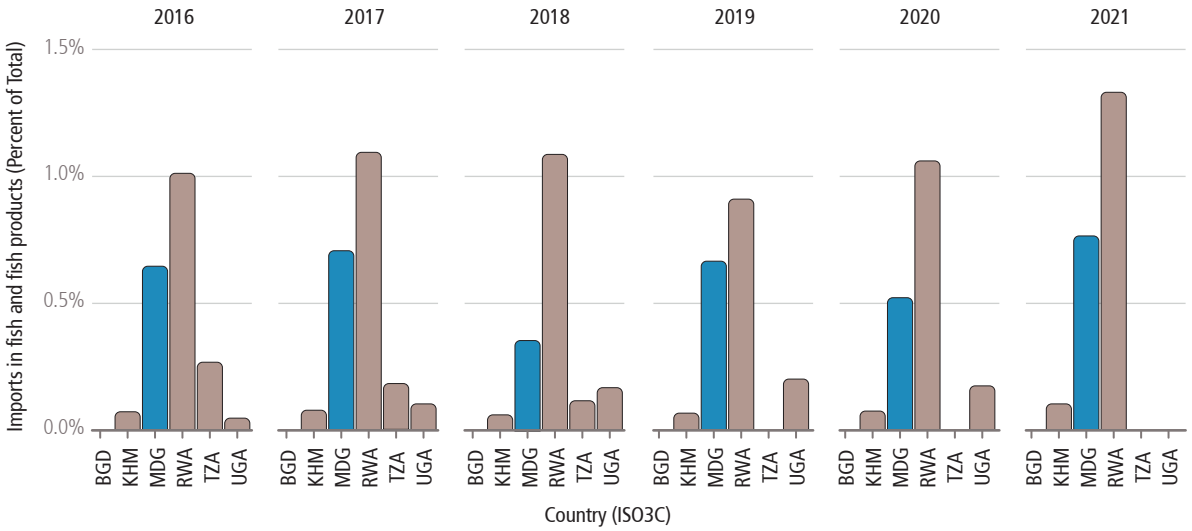
30. Fish and fish products are a major constituent of Malagasy exports, accounting for 7 percent of exports in 2020 (Figure 3), with 84 percent exported to the European Union and 7 percent to China and the remainder split between a dozen countries. Most traded seafood products have been prepared or preserved, presumably by freezing.

Figure 3. Exports of Fish and Fish Products as a Percentage of Total Exports, Madagascar and Peer Countries



31. Although commercial fish processing is widespread in Madagascar, as the large amount of processed and preserved fish products exported indicates, post-capture loss is also high in the small-scale sector, which should be addressed as soon as possible. In addition, lack of infrastructure and social services, limits opportunities to add to the value of caught fish (e.g., cleaning, processing, packaging, marketing). Domestic production is limited and imports of fish and fish products accounted for 1.75 percent of total imports in 2021—more than in any of the previous five years (Figure 4).

Figure 4. Imports of Fish and Fish Products as a Percentage of Total Imports, Madagascar and Peer Countries



32. Owing to their significance, fisheries must play a role in climate change adaptation and mitigation in Madagascar, but many climate impacts are unknown, and additional evidence is necessary to provide recommendations.

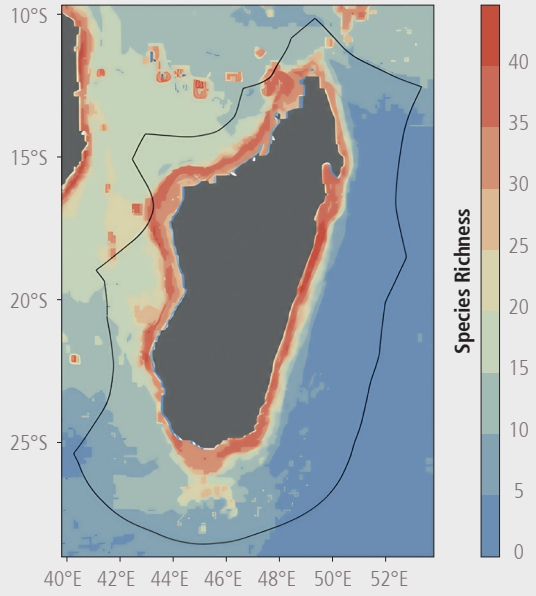
33. Fisheries will have an increasingly important role to play in increasing food security in Madagascar. Although changes in agricultural production are difficult to predict, climate change has the potential to lower crop yields dramatically through natural disasters such as droughts. Creating healthy, resilient fisheries decreases reliance on agriculture, which increases food security and reduces climate risk.

34. Building adaptation capacity in Madagascar's fisheries depends upon developing a high-quality evidence base to inform planning and investment. Climate Change and Marine Fisheries in Africa (World Bank 2019) modeled country-level changes in Madagascar's expected fisheries yield and socioecological risk and found that Madagascar was among the least-affected countries in Africa in terms of fisheries yield reductions. Additional subnational evidence is necessary to direct investment, estimate the distributional consequences of climate impacts on coastal fisheries in Madagascar, and determine the extent to which fisheries can be considered a reliable source of food and livelihoods as climate change progresses.

35. Fisheries also have an important role to play in climate change mitigation. Although Madagascar is among the world's lowest emitters per capita of greenhouse gases, poorly designed fisheries subsidies can contribute to climate change by increasing emissions while also threatening the health of stocks that fishers depend upon for their livelihoods. Eliminating harmful subsidies and improving practices will increase sustainability while also mitigating climate change.

36. The highest species richness values[4] were found along the coast of Madagascar, with mid values of species richness observed in the Mozambique Channel (Map 2). The eastern side of Madagascar's EEZ had low species richness values in pelagic waters (Figure 5). Habitat suitability was similar to species richness, with the highest habitat suitability values found near the coast, mid habitat suitability values found in the Mozambique Channel, and had low habitat suitability found in the pelagic waters on the eastern side of the EEZ (Figure 6). On average, changes in habitat suitability are expected to decrease throughout the EEZ in the middle and end of the century. Habitat suitability is projected to increase only in the southeast portion of Madagascar's EEZ for both future time periods.

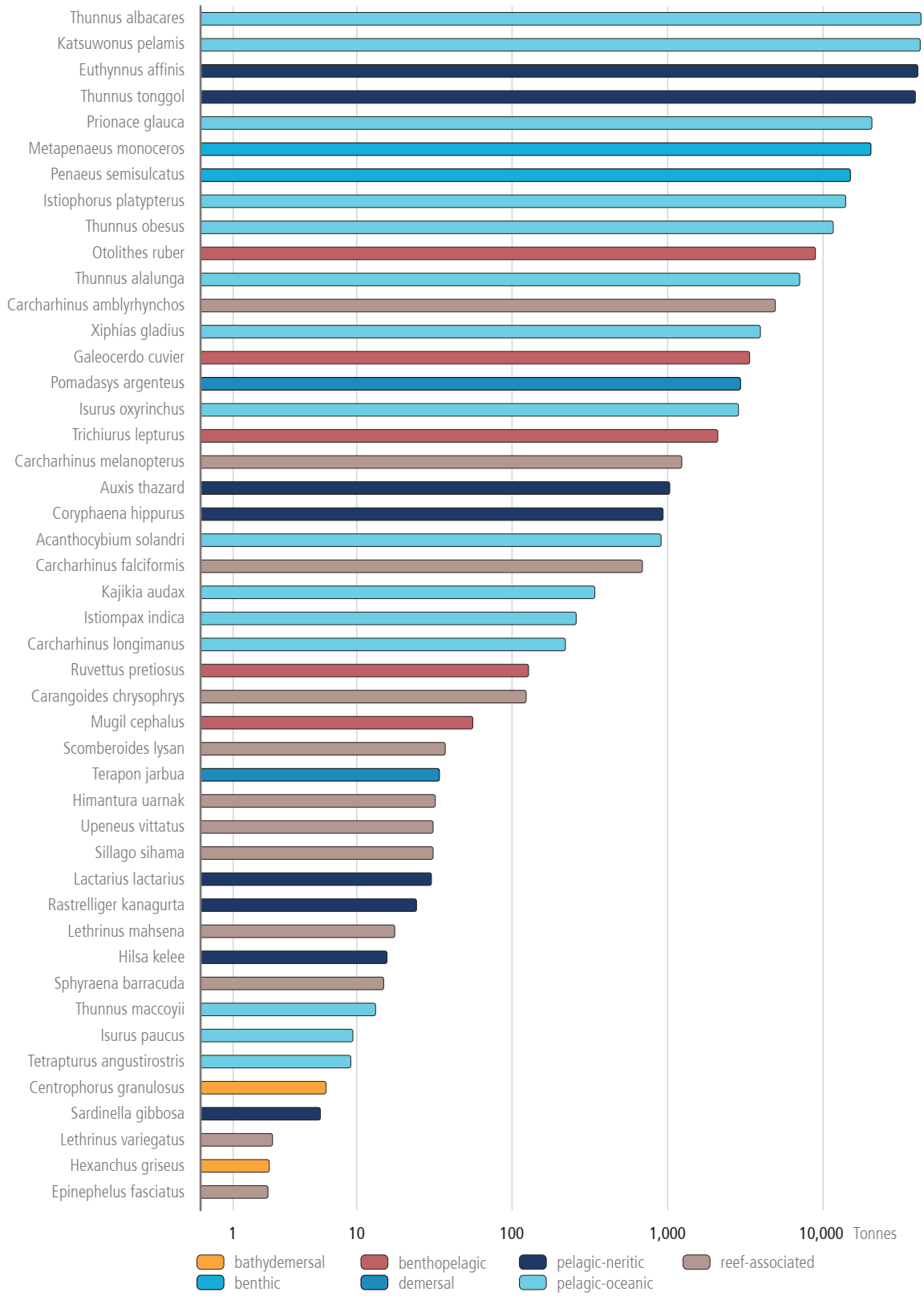
Map 2. Predicted Species Richness



Note: Solid black line represents Madagascar's exclusive economic zone.

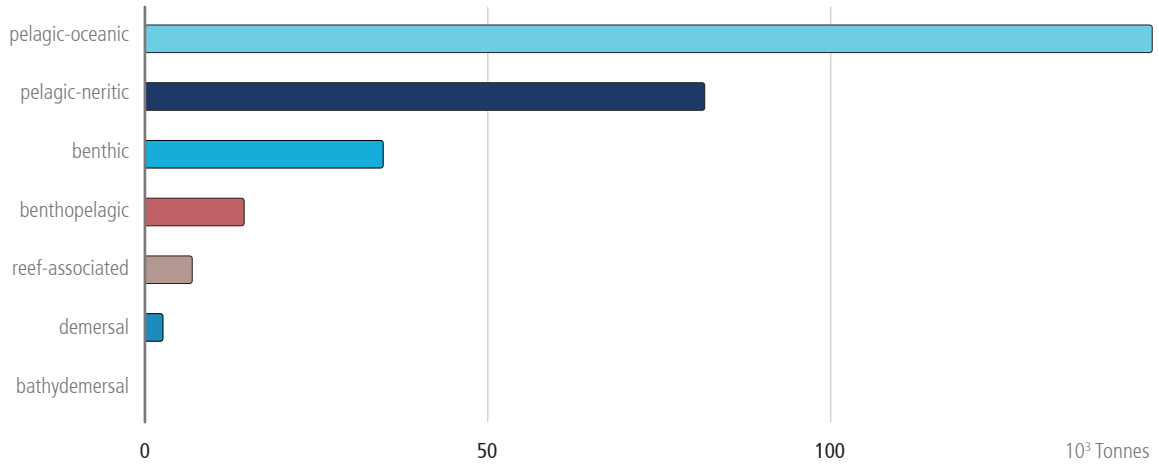
4 Species richness is calculated as the number of focal species predicted to occur in a spatial cell based on the ensemble-mean predictions from the 12 species distribution models.

Figure 5. Focal Species Represented in Total Catch and Their Associated Ecological Zones, 2009–19



Note: Focal species are species that are the focus of a conservation effort and are used to plan and manage nature reserves.

Figure 6. Proportion of Total Catch According to Ecological Zone, 2009–19



Coastal Natural Resources and Ecosystems

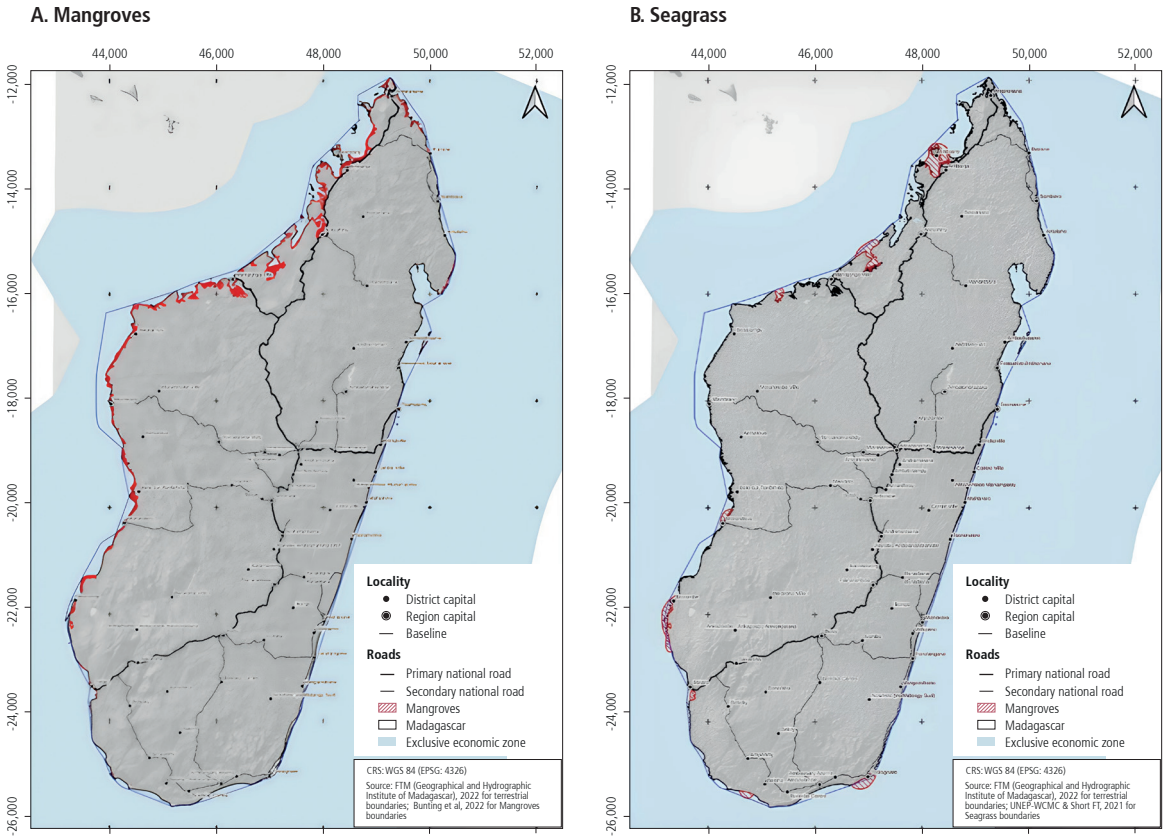
37. Madagascar has rich coastal natural resources, and mangrove, seagrass, and other ecosystems protect the livelihoods and economic activities of coastal populations. Enough fish is available to meet the nutritional needs of the entire country.

38. Madagascar has eight species of mangroves, grouped into six families. Most of the species are viviparous *(Rhizophora mucronata, Bruguiera gymnorrhiza, Ceriops tagal)*, meaning that the seed remains attached to the parent plant and germinates into a protruding embryo (propagule – baby tree) before falling from the tree. Mangroves can be found mostly on the western coast (Map 3A) and play a vital role in Madagascar's coastal ecosystem, providing habitat for a variety of marine organisms, including fish, crustaceans, and mollusks; filtering pollutants from seawater, which improves water quality; and protecting shorelines from erosion by reducing wave energy. Mangroves also have economic value. They are harvested for a variety of purposes, including timber, charcoal, and firewood (Scales and Friess 2019) and support important ecosystem services, such as tourism and recreation (Spalding and Parrett 2019). Climate change is causing sea levels to rise, which can inundate mangroves and make them more susceptible to damage from storms. Deforestation is also increasing sedimentation and nutrient runoff, which can damage mangroves. Pollution from agricultural runoff, sewage, and industrial activity can damage mangroves by reducing water quality and increasing the abundance of harmful algae.

39. Seagrass meadows are found in shallow coastal waters, typically in depths of less than 5 meters. They are most common in sheltered bays, estuaries, and lagoons, where they are protected from strong currents and waves. Seagrass meadows can be found along the entire coast of Madagascar, especially along the western coast, and are most abundant along the northwestern coast, where there are more sheltered bays and estuaries (Map 3B). It is estimated that seagrass beds cover 2,000 to 4,500 km^2 in Madagascar, but lack of data prevents precise assessment (World Bank 2022). Based on data from the United Nations Environment Programme World Conservation Monitoring Centre,[5] the area covered by seagrass may be greater than 4,500 km^2.

5 United Nations Environment Programme World Conservation Monitoring Centre and Short FT (accessed 2024).

Map 3. Location of (A) Mangroves and (B) Seagrass



Innovative Ecosystem Services and Infrastructure

40. Madagascar has large reserves of marine and coastal natural capital, including some of the largest mangrove forests in the world, extensive seagrass beds, and a large area of coral reefs. These ecosystems are highly effective carbon sinks; mangroves sequester up to five times as much carbon as terrestrial forests, and seagrasses can store up to 15 times as much carbon per hectare as mangroves. Estimates of blue carbon in the Malagasy EEZ range from 18,500 to 45,500 tonnes of carbon per square kilometer for mangroves and 923 to 2,447 tonnes of carbon per square kilometer for seagrass beds.

41. Mangrove and seagrass ecosystems also provide important economic co-benefits. Mangroves protect against coastal erosion; act as buffers against natural disasters, particularly cyclones in coastal areas, and tides; prevent saltwater intrusion of freshwater aquifers; provide habitats for fish, shrimp, and other marine wildlife; and are attractive to tourists and those seeking recreation.

42. These ecosystems must be protected to prevent release of stored carbon and to continue sequestration. Unfortunately, Madagascar's mangroves are being rapidly degraded, with a 20 percent decrease between 1990 and 2010 and, in some areas, clear-cut for wood products (timber and charcoal) and converted to small- and semi-industrial-scale agriculture and aquaculture. In an attempt to combat degradation, Madagascar has created a network of protected areas.

Other Sectors

43. Although fisheries is the dominant oceanic sector in Madagascar, other sectors have been identified as having growth potential and must be evaluated for their climate impact and exposure to climate risk. Development must be pursued in these sectors in the context of a blue economy approach to minimize conflicts and maximize synergies, especially given that spatial conflicts are likely (e.g., in the case of aquaculture and mangrove forests).

- *Tourism.* Madagascar has less international tourism than regional peers, although before the COVID pandemic, tourist arrivals were increasing, primarily drawn to nature-based and marine tourism. Madagascar's biodiversity and protected areas offer a unique value proposition to ecotourists. Such a tourism model is inherently climate resilient, and revenues can support sustainable development in other sectors and defense of coastal ecosystems. Actions can be implemented to support investment in tourism (Table 2). Climate change can affect the supply of and demand for tourist activities.

    - Impacts on tourism supply

        - **Natural assets:** Warming coastal waters can increase seaweed growth, causing outmigration of coastal fish, and accelerate coral bleaching, diminishing many of the assets upon which marine tourism depends. Sea level rise will increase coastal erosion, degrading beaches and related attractions.
        - **Infrastructure:** Increases in flooding and storms and sea level rise will damage tourism infrastructure, particularly in coastal areas (e.g., ports, tourist piers, artisanal marinas).
        - **Private sector operations:** Shifts in water availability may complicate tourism operations such as hotels. Costs of repairs and rebuilding after extreme weather events will be additional financial burdens on operators still recovering from COVID-19 impacts.

    - Impacts on tourism demand

        - **Geographic dispersion:** Temperature increases are likely to shift tourism demand away from already-warm coastal destinations toward cooler, inland, higher-altitude attractions. Areas experiencing more frequent cyclones and flooding will become less attractive.
        - **Seasonality:** Higher temperatures and extreme weather events in certain months are likely to affect seasonality patterns, concentrating visits in cooler months.
        - **Tourist experience:** Degradation of key coastal assets (e.g., coral reefs, fauna populations) will diminish the overall tourist experience and reduce the destination's attractiveness. Increases in extreme weather events are likely to raise concerns about safety and security, decreasing the desirability of the location and thereby reducing demand.
        - **Willingness to travel:** Tourists may feel increasing pressure to avoid flights to limit emissions, decreasing overall demand for this mainly long-haul destination.

Table 2. Coastal Tourism Priority Capacity Development, Investments, and Reforms

Action	Prerequisite reforms (what it will take to implement recommended intervention)	Cost estimate (USD/year)	Recommendation
Quick wins (priority investments that can be implemented by 2030)			
Collect baseline data on tourism and climate change to measure risks, inform strategies, monitor impacts, and facilitate advocacy for sector resources.	Ensure public sector willingness and capacity for interministerial collaboration (Ministry of Tourism, Ministry of Environment and Sustainable Development, Ministry of Territorial Development and Land Services) and collaboration with private sector. Prioritize most-visited or most-at-risk tourism attractions to study to manage scope.	~250,000 for 1-2 years to establish a baseline Subsequent ongoing costs for periodic updates, data management	Ensure that private sector actively contributes to data collection (e.g., client surveys; reporting on demand trends, economic impacts, product adjustments).
Promote participatory, public-private, destination-level approaches to management of coastal and marine attractions.	Ensure local-level, multistakeholder buy-in, including of local communities. Piloti destination-level, collaborative approach to safeguarding and managing coastal tourism assets, integrating best management practices from other destinations.	~200,000 for 1-2 years to pilot establishment of destination-level management platform and preparation of management plan in at least one destination Subsequent costs for implementation of management plans and actions	Encourage innovative financing mechanisms for private sector to contribute to management of assets.
Develop climate-specific tourism promotion and crisis communications.	Develop market intelligence to identify markets that climate change is most likely to affect and that have the greatest potential for growth (e.g., regenerative travel segment) and their priorities. Build capacity for tourism authorities and private sector on climate-specific promotion and crisis communications.	~200,000 (one-time investment)	Ensure that private sector adapts their tourism marketing.
Mid- to longer-term actions (priority investments that can be implemented by 2050)			
Develop programs to support private sector adoption of adaptive practices and product diversification.	Create mechanisms for financing and technical assistance for private sector beneficiaries. Facilitate access to equipment, materials, and technology through imports or stronger local sourcing.	6-7 million, depending on uptake	Use financing mechanisms that use a co-financing or matching grant model (e.g., 20% match).

- *Transportation.* Madagascar's national maritime fleet is modestly sized and transports fuel, food, and cargo. Marine transportation infrastructure is poorly maintained and obsolete. Investment in blue transportation—including low-carbon fuels and transshipment facilities—could mitigate climate change while increasing the attractiveness of ports.
- *Aquaculture and mariculture.* Madagascar's aquaculture (seafood faming in a self-contained environment) and mariculture (seafood farming in open water) sectors are growing, with extant farms producing shrimp, seaweed, and sea cucumber. Community-managed aquaculture supports the incomes of coastal communities, has low environmental impact, and can contribute to sequestration and storage of carbon, but development of aquaculture and mariculture cannot come at the expense of existing ecosystems. Climate change threatens to further affect development of the sector, with sea level projected to rise by 11 cm by 2030, 22 cm by 2050, and 43 cm by 2080, leading to saline intrusion in coastal waterways and groundwater reservoirs. This in turn is likely to affect aquaculture production facilities and aquaculture breeding programs.
- *Offshore renewable energy.* The Madagascar Country Environmental Assessment revealed that offshore wind potential is high on the northern and southern coasts. More-speculative renewable energy generation options are also possible, including ocean current energy, wave energy, and floating solar power.

Financing

44. Although there is an urgent need to secure sustainable financing for protected areas, attempts to monetize blue carbon have stalled, and pathways forward are unclear.

45. In 2021, Madagascar nationalized its carbon rights and issued a moratorium on the sale of carbon credits; the government owns all emission reductions, and only the government may commercialize them. This has disrupted existing initiatives, including the sole mangrove conservation project in Madagascar under the Reducing Emissions from Deforestation and Forest Degradation umbrella. There has been no attempt to commercialize nationalized rights.

46. Marine protected areas must be developed and administered in cooperation with affected communities to maximize benefits, promote compliance, and prevent unintended consequences in communities that depend on resources in protected areas for survival. Benefit-sharing arrangements should be explored.

47. Identifying pathways to monetize marine protected areas will help protect vulnerable coastal ecosystems and vital ecosystem services that promote growth in Madagascar and will allow the government to participate in innovative climate finance schemes for the benefit of the country and coastal communities.

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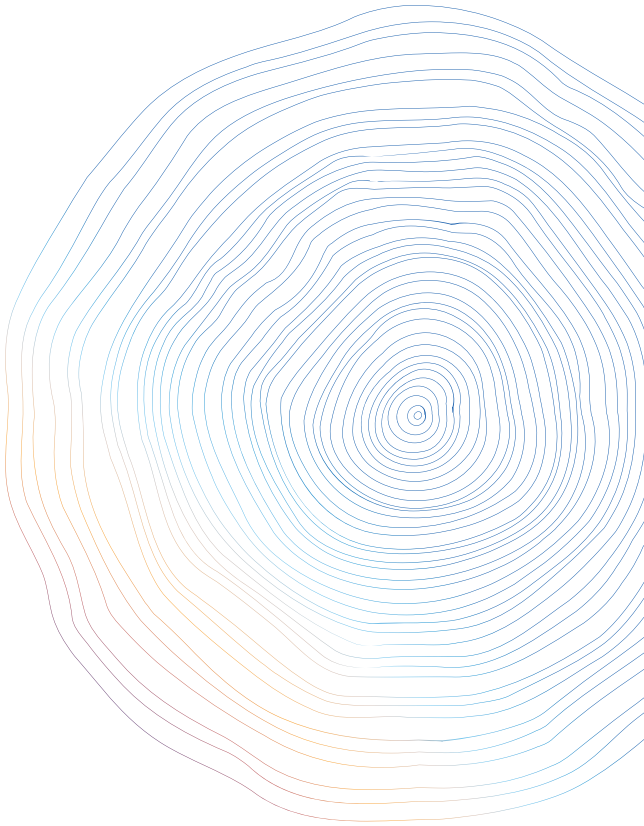

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