True Risk

The environmental risks of deep-sea gas exploitation in the Rovuma Basin of Cabo Delgado, Mozambique

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Justiça Ambiental! (JA!) / Friends of the Earth Mozambique: JA! is a civil society organisation in Mozambique that supports environmental justice at community, national and international level. JA! views the environment as an holistic concept and thus environmental justice as the act of using the environment as a vehicle for ensuring equity and equality across society. In support of sustainable development they view the concept of equality on a grand scale, and as such, values the rights of future generations to a healthy and safe environment, to the same degree that that right is valued for humanity.

FFCSA is a civil society coalition working towards ensuring that public finance institutions invest in a sustainable manner in Southern Africa. The Coalition focuses on issues of climate change, power generation, and transparency & accountability as they relate to public finance institutions operating within the region. The Coalition currently consists of the following organisations: 350Africa.org, Centre for Environmental Rights, African Climate Reality Project, Centre for Applied Legal Studies, Oxfam South Africa, Justiça Ambiental!, and Earthlife Africa.

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Reader's Notes

The gas projects

- The Rovuma Basin is located offshore in Cabo Delgado Province, Mozambique. Natural gas fields are confirmed in two concession areas, Area 1 and Area 4, about 50 km offshore, and at ocean floor depths of up to 2,3 km below sea level.
- As of June 2025, a total of four gas extraction projects are planned.
- In Area 1, the Mozambique LNG project began construction in 2019 but has been suspended since April 2021 because of ongoing regional violence.
- In Area 4, the Coral South FLNG project is operational, and the Rovuma LNG and Coral North FLNG projects have not reached final investment decision.

The gas project EIAs

- The critique of the Rovuma Basin gas project EIAs in this report is indicative rather than comprehensive. It is understood that the flaws exposed are pervasive in mega-project EIAs across the world, with serious implications for the sustainability and health of ecosystem biodiversity.
- In 2014, a joint EIA was conducted for the Mozambique LNG and Rovuma LNG projects. In 2019, an update was conducted for Rovuma LNG, and in 2020 for Mozambique LNG, with both relying on the original 2014 EIA as a basis.
- The EIA for Coral South FLNG was conducted in 2015.
- The EIA for Coral North FLNG was conducted in 2024. It overlaps with the EIA for Coral South.
- Specific points of critique on the content of the EIA documents referenced were identified by Dr Joshua Dimon and Dr Chris Engelbrecht.
- In addition, critique was formulated by Natural Justice and Justiça Ambiental!, for submission to the EIA process for the Coral North FLNG: 'Comments on the Preliminary Report of the Environmental Impact Study of FLNG Coral Norte project', (30 May 2024). Supporting comments were drawn from this submission.
- The Coral North EIA is the most recent of the four EIAs and would be expected to contain the most up-to-date consideration of the baseline environmental status for the Rovuma Basin, as well as the most current mitigation approaches. It serves as an illustrative example of the serious flaws in the methodology of the EIAs for the Rovuma Basin gas projects.
- All critiques of environmental impact assessments in this report, as well as general information on the gas projects discussed and the biodiversity baseline information, refer to the EIAs of the four projects (details in the references section), unless otherwise referenced.
- Additional detailed critiques of the Rovuma Basin gas project EIAs are available on request.

Abbreviations

AIS	alien invasive species	$GtCO_2e$	Gigatonnes carbon dioxide equivalent
CIA	cumulative impact assessment	IPCC	Intergovernmental Panel on Climate Change
CN-EIA	Coral North FLNG EIA (2024)	LNG	liquefied natural gas
CN-FLNG	Coral North FLNG	M-ESHIA	Mozambique LNG Environmental, Social and Health Impact Assessment (2020)
CS-EIA	Coral South FLNG EIA (2015)	Moz-LNG	Mozambique LNG Project
CS-FLNG	Coral South FLNG	RCB	remaining carbon budget
EIA	environmental impact assessment: the term is used as both noun and verb in this report	R-ESS	Rovuma LNG Environmental and Social Supplementary Lender Information (2019)
FLNG	floating liquefied natural gas	Rov-LNG	Rovuma LNG Project
GHG	greenhouse gas	RM-EIA	Joint EIA for Rovuma LNG and Mozambique LNG (2014)

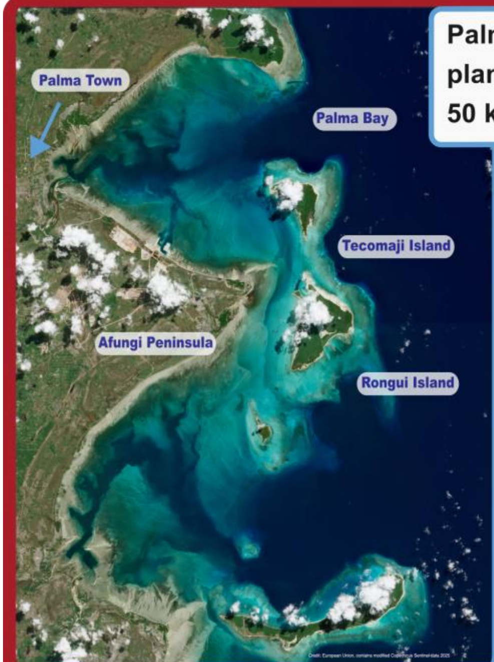
Summary and key conclusions

The Rovuma Basin in Cabo Delgado, northern Mozambique, is targeted for gas exploitation, to produce liquefied natural gas (LNG). As of June 2025, one project is operational, one is suspended because of regional violence, and two do not have final investment decisions.

Palma Bay and the Afungi Peninsula to its south are intended as a base for large infrastructure. Onshore processing plants are planned, and Palma Bay will be altered to accommodate marine infrastructure and large ships. The deep-sea environment will be affected by gas wells, extensive pipe networks, and related infrastructure.

An assessment was made of the state of knowledge and understanding about the ecology of the region, the impacts of deep-sea gas exploitation, and the environmental risk assessments of the four gas projects. It indicates that there is an urgent need for more data to enable a broader and more reliable understanding of the combined impacts of future fossil gas extraction, existing impacts from current and past activities, and emerging stresses resulting from locked-in climate change impacts.

- Current scientific understanding of the impacts of deep-sea gas exploitation is not adequate to be able to make reliable assessments about the impacts of gas projects on the Rovuma Basin and surrounding region.
- There is currently a poor understanding of the ecology and biodiversity of the Rovuma Basin region, and it is therefore impossible to make reliable assessments about how they would be affected by gas exploitation.
- The full environmental and climate risk of the gas projects in the Rovuma Basin is much greater than the assessments made in the formal environmental impact assessments (EIAs) conducted for the projects.



Palma Bay and the Afungi Peninsula are targeted for gas plants and marine facilities, with plans to drill wells about 50 km east, in waters up to 2,3 km deep.

Given the glaring data gaps with respect to the deep-sea impacts of gas exploitation activities, application of the Precautionary Principle, or First Do No Harm Principle, should be mandatory in project EIAs.

The Precautionary Principle demands:

- **Plan for the worst when data are lacking;**
- **Protect before damage becomes certain;**
- **The burden of proof when dismissing risk lies with the developers.**

Summary of the flaws in the gas project EIAs

The Rovuma Basin gas project EIAs deviate from commonly accepted EIA guidelines, and are deficient in many respects, to the extent that they cannot be considered a valid base for informing approval of the planned projects or mitigation of their impacts.

- The risks and impacts of gas development on the ecology of the region are under-represented and understated.
- Cumulative impacts are understated and incompletely formulated.
- The full lifetime emissions (Scope 3) that would result from these projects are neither calculated nor considered.
- No thorough, scientifically sound surveys were conducted on ecosystems and biodiversity in the terrestrial, near-shore or deep ocean areas affected, which indicates that the relevant impacts on the region are poorly understood. This weakens the validity of the EIA assessments and renders them ineffective.
- There is no comprehensive coverage of any of the impacts of the gas exploitation activities on marine life in the affected region.
- There is no thorough, scientifically sound assessment of all potential chemical pollution impacts. The impacts of gas and gas condensate leaks from wells and pipes are not considered.
- The impact of alien invasive species is significantly underestimated.
- Acoustic impacts are understated and limited in scope, and the assessments do not include impacts from the extensive marine traffic that would accompany the gas projects – in particular, the continuing arrival and departure of LNG carriers.
- Application of the Precautionary Principle, or the First Do No Harm Principle, is not evident for any of the Rovuma Basin gas projects.

Summary of the impacts of the gas projects

It is possible to limit average global warming to under 1.5 degrees C only if fossil fuel use is scaled down extremely rapidly, and if no new fossil fuel projects are built. In order to adhere to the 1.5 degrees C threshold, present LNG export capacity is already sufficient to meet current and future demand, and no new gas infrastructure should be developed. The climate impact of the projects have not been addressed sufficiently in the gas project EIAs.

- The operation of the proposed gas projects and the burning of the LNG produced would contribute significantly to exceeding an average global warming threshold of 1.5 degrees C.
- The combustion of the LNG produced by the Rovuma Basin projects would consume at least 7.5% of the remaining global carbon budget (RCB) – for an 83% chance of staying under 1.5 degrees C.
- If the full estimated reserves of the Rovuma Basin gas fields are extracted, processed and burnt, this would result in emissions of 9.9 $GtCO_2e$. This would consume at least 17% of the current global 83% RCB.

Chemical pollution resulting from gas exploitation, including leakage of gas and gas condensate and spills from operations and marine traffic, is a potentially severe hazard to marine ecosystems, but the impacts are not well studied. Gas and condensate leaks can be expected from wells and pipelines. Condensate is toxic to a range of marine creatures and, for copepods, is twice as toxic as crude oil. Gas condensate also tends to linger for long periods of time below the surface, compared to crude oil.

Alien invasive species (AIS) have significant impacts on tropical marine ecosystems, specifically seagrass beds, coral reefs, and mangrove forests, and result in profound global ecological change. The Rovuma Basin region is highly vulnerable to AIS, and it would be nearly impossible to eliminate them once they become established. They are introduced through ship ballast water and, conservatively, at least 15,000 LNG carriers could be expected over the course of the gas project lifetimes. The cumulative impact of multiple invasive populations could be catastrophic, and the impact to ecosystems will not be limited locally.

The projected acoustic impact of the Rovuma Basin gas projects can be confidently stated to be severe. Introducing sounds into the ocean that are not within the normal range of marine creatures is disturbing and confusing because of the ways in which marine organisms use sound signals. Severe acoustic impacts will result from marine drilling, operational gas wells, the ongoing operations of FLNG vessels, and the marine traffic associated with the gas projects. This acoustic pollution will have physiological and behavioural impacts on marine mammal behaviour, is harmful and even fatal for zooplankton, and impacts fish behaviour and invertebrates.

Drilling and dredging for marine facilities, the pipeline networks, and gas wells will result in significant physical damage to the marine environment, produce toxic wastes, and reduce water quality. Drilling waste is toxic to aquatic organisms, but the impacts on deep-sea ecosystems are largely unknown. Turbidity resulting from dredging and drilling will reduce water quality, which will affect marine life.

In the deep ocean, anchors and other infrastructure for the FLNG vessels and drilling vessels disturbs the seabed and increases sedimentation. Drill cuttings or waste can smother seafloor creatures and permanently modify the seabed, and harm deepwater reefs. For Coral North FLNG, each well could result in 1,350 m^3 of drilling waste.

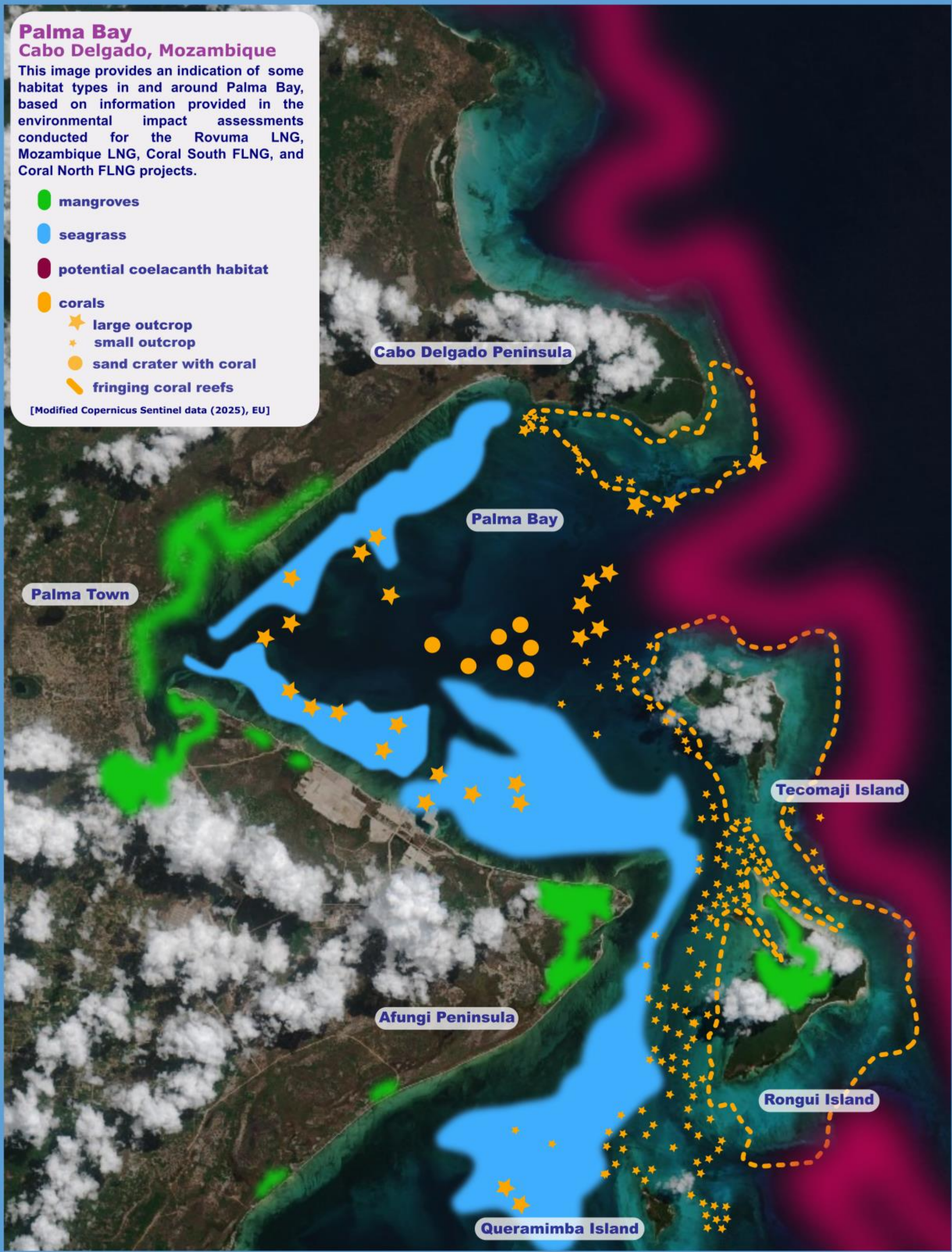
Palma Bay, the Cabo Delgado Peninsula to its north, and Tecomaji and Rongui islands to the south-east will all be severely impacted by dredging. Dredging in Palma Bay would produce at least 12 million m^3 of waste. This will result in damage to sea grass beds and coral reefs which provide food and shelter to small and large marine creatures.

Next steps

Where there are inadequate data, the Precautionary Principle (PP), or First Do No Harm Principle, must be applied.

An immediate moratorium should be placed on all four Rovuma Basin gas projects, in application of the Precautionary Principle, at least until there is a thorough understanding of the ecological value of the Rovuma Basin and Afungi Peninsula as well as a thorough understanding of the full projected impacts of the gas projects on the habitats and biodiversity of the region.

Map of Palma Bay



Introduction

Mozambique's Rovuma Basin, within one of both the Indian Ocean and Africa's most important biodiversity centres, and already subject to climate change related stress, would be exposed to very significant additional environmental impacts by offshore gas exploitation – if planned LNG projects are financed or able to operate in the region.

These risks would be exacerbated within the current context of volatile energy markets and national and regional instability.[1] Given the absence of physical borders in the ocean, the potential impacts would extend beyond the Rovuma Basin itself into areas located along the ocean currents and across the Western Indian Ocean.

This assessment establishes that the present scope of research-based assessment and understanding of the Rovuma Basin's marine environment and of the comprehensive impacts of deep-sea gas development are inadequate for a thorough and reliable assessment of the true impacts that gas extraction activities would have on the affected ecosystems and biodiversity, peoples, and economies.

The Rovuma Basin lies off the coastline of Cabo Delgado province in the north of Mozambique. It is situated within a globally important biodiversity hotspot, and special care should be taken to avoid any risk to the region's ecosystems. Deep-sea gas exploration is a relatively new activity, and there are limited research findings specifically on its impacts on the local marine environment and biodiversity, regional marine and terrestrial ecosystems, or climate systems.

Commercially exploitable reservoirs of fossil gas (estimated at 150 –180 trillion cubic feet or 4,2 – 5,1 trillion cubic metres)[2] are targeted for extraction in two adjacent concession areas within the Rovuma Basin. Four gas projects are planned, one of which is operational. In this report, the environmental impacts of the envisaged gas projects are analysed on the basis of both available knowledge and the identified lack of adequate data.

Considering the nature of the developments and the dependence of the region's people on marine and terrestrial ecosystems for survival,[3] a thorough risk assessment should include a comprehensive and scientifically sound survey of the marine and terrestrial ecology and biodiversity throughout the impacted area and incorporate the full range of impacts – especially the cumulative impacts – from processing facilities, wells, pipelines, marine traffic, and supporting infrastructure. These impacts include chemical, acoustic, and physical pollution as well as climate change and alien invasive species.

If the methodologies followed in assessing the ecological and biodiversity baseline are not meticulously executed, and if species and habitats that occur in the region now are not detected and listed comprehensively, the assessment of project impacts (for example, in five years' time), would be distorted: If species and habitats disappear locally, a lack of rigour in establishing the baseline would generate a false conclusion that the project had no impact.

It is possible that a high proportion of so-called "data deficient species" – species that are not well researched and for which there is no adequate understanding as yet – may be threatened;

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[1] *ACLED, (2025); Gaventa J, (2021); van Teeffelen J and V Kiezebrink, (2023); Halsey R, et al, (2023); Runciman J, (November 2024); IEA, (October 2024); Nicholas S, (February 2025)*
[2] *ECIC, (2020)*
[3] *Abbas M et al, (2021)*

however, they may not be factored into conservation strategies exactly because of the lack of data. Data deficient species may even be more threatened as a group than data sufficient species.[4]

With marine cetaceans, for example, many of the data deficient species are among those most likely to be endangered.[5] Omura's whale, classified as data deficient,[6] is a rarely seen species known to occur in the Mozambique Channel off Madagascar, but has not been recorded in the Rovuma Basin. The species is thought to be non-migratory and found only in tropical and warm-temperate waters.[7] The presence of coelacanth has also not been established in the Rovuma Basin although potential suitable habitat exists. Without knowing whether these species occur in the region, it would not be possible to design an effective conservation strategy – or to determine appropriate and effective mitigation for the impacts of the gas industry.

Knowing whether we are nearing a point of fundamental system change versus knowing that something will cause some vaguely defined negative impact on a system are very different kinds of knowledge. In order to avoid potentially catastrophic consequences, cumulative impact assessments (CIA) are required to assess the role of concurrent projects as well as past impacts to system health and the dynamic state of a system.

As Loreau (2010) notes, "[o]ne of the distinctive and fascinating features of ecological systems is their extraordinary complexity. An ecosystem is often composed of thousands of different species that interact in myriad different ways at the scale of a single hectare. These complex local systems are strongly connected to each other".[8]

Ecosystem dynamics are nonlinear and highly interconnected or interdependent – including the interaction between ecosystems and human activities.[9] The nonlinear features of ecosystem dynamics are often underestimated by human analyses.[10] The full features of ecosystem dynamics and interconnectedness should be considered in order to avoid very consequential errors when assessing the severity and gravity of any risks of human activity on ecosystems.[11] This includes the risks posed to the marine environment by practices such as industrial fishing, seabed mining, and seafloor extraction of oil and gas.

In some cases, ecosystems can collapse suddenly – like a light switching off – when systems pass tipping points beyond recovery. Nonlinear systems are naturally subject to sudden, dramatic transitions or shifts from one stable state to a different stable state.[12] An example of an ecological system transitioning from one stable state to another is the conversion from forest to grassland in the Amazon region: both forests and grasslands are stable within their current dynamics until there is an external stressor, for example slash-and-burn for cattle ranching or soy production. Such a shift is hard to reverse, particularly if the system has shifted to a lower – or less complex – energy state. Ecosystems are vulnerable to a number of such sudden transitions. The complexity of marine ecosystems is increasingly being recognised,[13] including the possibility of sudden shifts in state, as evident in coral bleaching events globally.[14]

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[4] *Borgelt J et al. (2022)*
[5] *Parsons ECM (2016)*
[6] *Cooke JG and Brownell Jr RL (2019)*
[7] *Cerchio S (2022)*
[8] *Loreau M (2010)*
[9] *Loreau M (2010)*
[10] *Brehmer B (1994)*
[11] *Levin S et al. (2013)*
[12] *Meron E (2015)*
[13] *Fogarty MJ et al. (2016)*
[14] *Hughes TP et al. (2010)*

The impact of climate change poses the single greatest threat to marine ecosystems. The ecosystems in and around the Rovuma Basin are acutely vulnerable to climate change, and have already been subject to excessive impacts – most visibly in the form of storms of longer duration, higher intensity, and greater frequency, and less visibly as consistently increasing ocean warming and a higher intensity and frequency of marine heat waves.[15] Over recent decades, new studies and reports have continuously revealed that the severity of the changes to the Earth's climate and ecosystems are underestimated, and that remedial measures should be implemented urgently. It is more difficult to measure the rate of decline of marine ecosystems than that of terrestrial ecosystems, and it is simply not known how rapid the rate of decline in the oceans could be.[16]

In order to adhere to the 1.5 degrees C threshold, present LNG export capacity is already sufficient to meet current and future demand, and no new gas infrastructure should be developed.[17] The operation of the proposed gas projects and the burning of the gas produced would contribute significantly to exceeding the benchmark 1.5 degrees C threshold, worsening the carbon lock-in, which would constitute a very substantial negative impact on ecosystems and biodiversity.

The Rovuma Basin is a region of high ecological value, and the known impacts of gas projects in combination with the significant known impacts of other human activities (climate change being the most prominent of these) already paint a grave picture of the Basin's potential future. From our analysis, it is clear that there is an urgent need for more data to enable broader and more reliable quantification of the combined impacts of future fossil gas extraction, existing impacts, and emerging stresses resulting from locked-in climate change impacts.

Where there are inadequate data, the Precautionary Principle must be applied, which demands that extra caution should be applied when assessing the potential risks of an activity until reliable data become available, in order to avoid underestimating risks. The use of the Precautionary Principle is motivated by the perceived ineffectiveness of environmental regulatory policy in the past.[18]

Given the glaring data gaps with respect to the deep-sea impacts of gas exploitation activities, application of the Precautionary Principle should be mandatory in project EIAs.

The Precautionary Principle demands the following:

- Plan for the worst when data are lacking;
- Protect before damage becomes certain;
- The burden of proof when dismissing risk lies with the developers.

The environmental impacts that would result from gas exploitation in the Rovuma Basin would be felt locally, regionally in the Indian Ocean, and globally. There is a need for higher sensitivity to the risks, given the lack of adequate data on the region and on marine ecosystems in general, coupled with inadequate understanding of the impacts of deep-sea gas activities. Until reliable information is produced to prove that gas exploitation will not cause irreversible harm to the environment/ecology of the Rovuma Basin and its surrounds, the Precautionary Principle demands a moratorium on the activities of the gas projects.

[15] *Venegas RM et al. (2023); Bruno JF et al. (2018)*
[16] *Fletcher C et al. (2024); Dinesh AS et al. (2023); Smale DA et al.; Duarte CM et al. (2020); Ceballos G et al. (2017); Ceballos G & Ehrlich P (2023)*
[17] *Runciman J, (November 2024); IEA, (October 2024); IEA ,(2021), IEA, (2023), IPCC, (2023)*
[18] *Leyenaar JA (2018); Taleb NN et al. (2014)*

The gas project operations

The Rovuma Basin has various gas fields, all about 50 km or more offshore in waters up to 2.3 km deep. Mozambique LNG (Moz-LNG) and Rovuma LNG (Rov-LNG) are intended to be large-capacity onshore operations, with gas piped from deep-sea wells to processing facilities on the Afungi Peninsula, on the south of Palma Bay. Coral South FLNG (CS-FLNG) and Coral North FLNG (CN-FLNG) are floating facilities with smaller processing capacities that are positioned near the wells. The environmental impacts on the marine and terrestrial environments broadly include chemical, physical, and acoustic pollution, climate change impacts, and alien invasive species from ship ballast water. These diverse impacts act together to form a cumulative impact on each life form present in the region.

Onshore projects

Marine and onshore facilities are planned for Palma Bay and the Afungi Peninsula. The MozLNG and Rov-LNG projects have joint land use rights to an area of about 7,000 ha on the Afungi Peninsula, for operations and infrastructure. Each project will construct and operate its processing plants separately on this area of land. They will also jointly develop and use facilities such as the marine docking and infrastructure facilities.

Communities were required to relocate from the area, and additional lands are being allocated for the replacement of their machambas (agricultural lands).[19] Moz-LNG is addressing resettlement matters at present.

Operations in brief:

- Wells are drilled into the seafloor to obtain the raw natural gas (initially up to 55 for Moz-LNG and 24 for Rov-LNG). Each well would take up to a year to complete, with all wells planned to be drilled within two years of starting operations. This indicates that for the duration of those two years, 30–60 drilling rigs would be operating continuously in the area.
- The raw natural gas is to be transported to onshore liquefaction plants through a network of pipelines laid on the seabed. About 1.1 km^2 of hard metallic structures and interconnecting pipelines would be placed on the seabed.
- A series of liquefaction plants (called LNG trains) on land would process the raw gas into liquefied natural gas (LNG). Space has been allocated for 14 trains, but two would be built initially for each project. A train consists of a sequence of processing units that remove unwanted elements from the raw gas – first impurities such as dust and water, then unwanted gases such as carbon dioxide, and finally other unwanted heavy gases. The temperature of the gas is lowered to minus 160 degrees C, at which point the methane gas becomes LNG. The volume ratio of raw gas to LNG is about 600:1.
- Processed LNG would be stored in storage tanks, and then piped to LNG carriers moored at loading jetties.
- LNG would be loaded onto LNG carriers (300-metre-long vessels), for transport to target markets. If both projects became operational with two LNG trains each, there could be at least 4 LNG carriers entering Palma Bay each week. At peak production, for both projects, 12–20 LNG carriers could be expected each week.[20]

[19] *M-ESHIA; JA! (November 2024); JA! (May 2025)*
[20] *RM-EIA, Chapter 04 Page 4-46*

During construction of the subsea systems, a workforce of about 1,400 would be present over a 4–5-year period, with accommodation partly onshore and partly on offshore vessels. In addition, about 40 construction vessels may be present at times.

The projects have lifespans of 25 years, with at least 700 operational staff. Supporting infrastructure that is planned within the Afungi site includes offices, accommodation facilities, construction and maintenance areas, power generation facilities (gas turbines), waste disposal facilities, water and wastewater treatment facilities, roads, and an airport. Some facilities are already built, including a resettlement village that houses some of the families affected by the resettlement for the projects.

Floating projects

Floating LNG plants are large vessels that receive raw fossil gas from wells on the ocean floor and process it into LNG onboard, for transfer to market via LNG carrier ships.

Operations in brief:

- A floating LNG plant, about 430 m long x 70 m wide, is anchored over the seafloor. It includes LNG processing and storage facilities, and facilities for about 200 crew members.
- Wells are drilled into the sea floor by drilling rigs or light construction vessels, with each well taking up to a year to complete.
- Raw natural gas is piped upwards to the FLNG vessel.
- On-board liquefaction facilities convert the raw natural gas to LNG.
- LNG is loaded onto 300-m long LNG carriers, directly from the FLNG vessel, for transport to markets. At peak production, one vessel is expected to arrive and depart from each FLNG vessel each week.

Both CS-FLNG and CN-FLNG are intended to remain floating in the same location for 25 years, at about 1,840 m to 2,150 m above the ocean floor. Each facility is indicated to export 88.24 million metric tonnes of LNG.

The gas project environmental risk assessments

Natural resources and wild food from Palma Bay and the surrounding areas provide livelihoods and basic needs for local families

The start of construction work on the Afungi Peninsula

Environmental impact assessments (EIA) are recognised and intended as a way of assessing the negative impacts of proposed or planned developments and then avoiding, minimising or offsetting those impacts through the design and management of project activities.[21] Each of the Rovuma Basin gas projects has conducted a formal EIA.

EIAs must be performed with levels of detail and diligence that identify the full impact and risk of activities in order to enable credibly informed decisions. Any lack of data should trigger research to establish sufficient data and understanding for informed decisions, and should not be used as a loophole to avoid good practice. A fundamental component of best practice in constructing an EIA is a proper assessment of cumulative impact – in all its facets.

In a properly conducted EIA, there is a need to establish the baseline biodiversity status in order to assess actual projects' impacts accurately. For example, it is incumbent to conduct a thorough, scientifically sound fish survey if there is not one at hand; and, to determine the true distribution and presence of coral reefs and sea grass beds, a scientifically valid and comprehensive seafloor survey should be conducted if a current survey is not available.

In many projects, the original purpose of EIAs (to avoid or address negative impacts) has been subverted, and they often manifest as merely bureaucratic exercises. This is illustrated through the intimate relationship between project owners and EIA consultants, as discussed in a 2024 study focused on the Mozambique gas projects.[22] Many projects procedurally receive EIA approval and are subsequently implemented without an adequate assessment of environmental impacts and risks. The idea of rejecting a project may not even be considered.[23]

With regards to gas projects in Mozambique, "a symbiotic relationship has formed between the state, transnational corporations and the transnational environmental consultant industry; and the

[21] *Morrison-Saunders A, (2023)*
[22] *Voskoboynik DM (2024)*
[23] *Enríquez-de-Salamanca A (2021)*; *Carr CJ (2017)*

function of EIAs has not been, in practice, to address and ameliorate the environmental and social impacts of the largest-scale industrial projects, but rather to legitimize environmental and social impacts".[24] Environmental management processes for the oil and gas sector in Mozambique are constrained because exploration and production sharing contracts are put into place before EIAs are conducted, which means that the state has a limited ability to impose any changes to the project after an EIA is produced.[25]

For the Rovuma Basin gas projects, an EIA was conducted in 2014 for the Mozambique LNG and Rovuma LNG projects jointly. In 2019, an update was conducted for Rovuma LNG, and in 2020 for Mozambique LNG, with both relying on the 2014 EIA as a basis. The Coral South FLNG EIA was conducted in 2015, and the Coral North FLNG EIA in 2024.

Our analysis indicates that the environmental risk of proceeding with these projects vastly exceeds the assessments in the formal EIAs. The EIAs are deficient in many respects, to the extent that they cannot be considered a valid base for decisions about approval and/or mitigation of the planned projects. Surveys of animal life, plant life, and geographical distribution of ecosystems were not performed exhaustively, which weakens the validity of environmental baseline assessments and renders them ineffective. There is no comprehensive coverage of the impacts on marine life in the affected region. The risks and impacts of gas development on the environment in the region are under-represented and understated. The full lifetime emissions (Scope 3 emissions) that would result from these projects are not considered in the EIAs. Application of the Precautionary Principle is not evident for any of the Rovuma Basin gas projects.

There is no evidence that the de facto purpose of the Rovuma Basin gas project EIAs was to protect and sustain the natural environment.

The ecological value of the region

The environments of the Rovuma Basin and Afungi Peninsula are made up of interconnected habitats that support biodiversity, local economies and the basic survival of human communities. The region is mainly unaffected by industrial development but is under strain from climate change impacts. Protecting and rehabilitating marine and coastal habitats is considered critical for protecting biodiversity, meeting human needs, and buffering climate change impacts.

The coastlines of the northern Mozambique Channel are an important centre of biodiversity for the Indian Ocean, outranked in terms of global importance only by the Coral Triangle region (where the Indian Ocean meets the Western Pacific).[26] Mozambique's coastal waters, as mating, calving, and nursery grounds for humpback whales, are identified for prioritising conservation measures as the Mozambique Coastal Breeding Grounds Important Marine Mammal Area (IMMA).[27] Quirimbas National Park lies immediately south of the gas projects; this is a UNESCO Biosphere Reserve within the Quirimbas Archipelago.[28]

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[24] *Dimon J (2016)*
[25] *Dimon J (2016)*
[26] *Förderer et al. (2018); Reuter M et al. (2019)*
[27] *IUCN, (2021)*
[28] *Pereira MAM (2021); UNESCO, (2024).*

Endangered marine species in the gas affected region include Sei whales which are present in winter, and green and loggerhead sea turtles. Critically endangered species include hawksbill and leatherback sea turtles. Sea turtle nesting has been recorded on Rongui Island and reported on Tecomaji Island.

The continental shelf of northern Mozambique is narrow, drops steeply, and is characterised by deep, wide canyons. Coelacanth, which live in undersea caves and canyons, are recorded off the coasts of South Africa, Mozambique, Tanzania, Kenya, Madagascar, and the Comoros.[29] It not known if they occur in the Rovuma Basin. Without knowing whether coelacanth occur in the region, along with other species that share their habitat, it is not possible to plan conservation measures, or even to assess how the species could be affected by human activities.

Human activities have caused devastation in marine ecosystems and habitats.[30] Every marine ecosystem is affected by multiple threats, with almost all of these threats resulting from human activity.[31] In a system that is already vulnerable, additional impacts from gas exploitation could rapidly trigger tipping points beyond which recovery will be impossible.

Rapid and accelerating ocean warming profoundly impacts marine biodiversity and ecosystems.[32] The Indian Ocean in the region of the Rovuma Basin has heated more than the average across the oceans and even in the absence of detailed studies of the region, it should be recognised that the system is already under strain.

Sea surface warming is especially rapid in the Indian Ocean and along coastal boundary currents.[33] It is expected that in the tropics, ocean warming and oxygen concentration will exceed natural variability by mid-century.[34] In some cases, coral reef bleaching events are already occurring too frequently to allow for recovery.[35]

Since May 2023, average global sea surface temperatures (SSTs) have "jumped" dramatically above the trend range of heating observed in the preceding *seventy* years.[36] Abnormally high sea surface temperatures were recorded in most oceans through 2024 and into 2025, reaching 20.87°C over the extra-polar ocean in 2024, with especially high temperatures in the North Atlantic, Western Pacific and Indian Ocean.[37]

Marine heat waves (MHWs) are occurring with increasing frequency and severity.[38] Multiple regions in the Pacific, Atlantic and Indian Oceans are particularly vulnerable to MHW intensification, because of a combination of high levels of biodiversity, the large number of these species that are at their warm range edges, and non-climatic human impacts.

Coral reefs and mangroves are considered highly imperilled,[39] and West Indian Ocean coral reefs are considered vulnerable to collapse at the regional level.[40] Impacts on the Rovuma Basin coral reef systems would be significant for global marine biodiversity.

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29 *NOAA Fisheries, (Accessed 2025); Hissmann, K., et al, (2006)*
30 *Halpern BS et al. (2007)*
31 *Halpern BS et al. (2007)*
32 *Venegas RM et al. (2023); Gattuso et al. (2015)*
33 *Venegas RM et al. (2023)*
34 *Bruno JF et al. (2018)*
35 *Moore K et al. (2018); Hughes TP et al. (2018)*
36 *Cheng L et al. (2024)*
37 *ECMWF, (January 2025)a*
38 *Dinesh AS et al. (2023); Smale DA et al. (2019)*
39 *Halpern BS et al. (2007)*
40 *Obura D et al. (2022)*

The gas fields are in deep oceanic waters at depths of 1,000 to 2,300 m below the sea surface. Surveys for gas exploration show the presence of deepwater coral and rugose reef structures to depths of at least 1,510 m. Sampling shows at least 110 species of sea-floor lifeforms around the potential gas well sites, including polychaetes, crustaceans, molluscs, and echinoderms. It is likely that reef structures occur throughout the gas field areas.

The near shore marine environment includes ecologically productive seagrass beds and coral reefs which provide foraging, shelter and nurseries for invertebrates and fish, such as sea urchins, starfish, sea cucumber, damselfish and crabs.[41]

Coastal habitats include mangrove swamp forests, salt marshes, sandy beaches, and mudflats. Mangroves growing along the estuaries host a wide range of crustaceans, molluscs, and bivalves such as oysters and barnacles. Eight mangrove tree species are found in Cabo Delgado, including in Palma Bay.

The Afungi peninsula has intermixed wetlands, grasslands, woodlands, and forest habitats. About 933 ha of wetland occurs within the gas project area, including 210 ha of estuarine systems. According to the RM-EIA, at least 40 mammal species are found here, including African wild dog, cheetah, hippopotamus, lion, elephant, and pangolin. More than 300 bird species are known in the region, including four globally threatened and seven near-threatened bird species.

The available information about the region’s ecology and the threats it already faces indicates that it should be prioritised for thorough research and protection.

Cumulative impacts

The full impact on a particular species or ecosystem results from the combination of all damaging impacts it suffers from different activities or projects, accumulated over time.

Living organisms experience inputs from their environment in their entirety. Analysing distinct types of impacts individually results in a gross underestimation of the actual impact experienced by an organism. It is the cumulative impact of all the distinct impacts that determines whether the organism will die or suffer long-term damage (or impairment).

With reference to the planned gas exploitation in the Rovuma Basin, the cumulative impacts would result from the combination of chemical, physical, and acoustic pollution; climate change effects such as ocean heating, acidification, and deoxygenation; and the effects of alien invasive species – accumulated from multiple projects, over the projected lifespans of the projects. While each individual impact may not seem severe when assessed in isolation, the cumulative impacts may be fatal or very damaging to a species.

Cumulative impact assessment (CIA) is expected to analyse all past projects and impacts in the project area that may already have reduced the resilience of social and ecological systems across those systems' geographic boundaries (e.g. watershed, airshed, fishery) – prior to the start of a new project. In addition, CIA is expected to analyse all other concurrent projects and programs affecting that area. It should reasonably predict future activities, given past experience and knowledge of the developments and regional context.

[41] *Gullström M et al. (2002)*

The International Finance Corporation (IFC) has issued a formal handbook[42] on the definition and interpretation of *cumulative impacts* in environmental impact assessments. In summary, it states that cumulative impacts "result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones".

There are two fundamental drivers of cumulative impacts:

- the *combined* effects of distinct factors on one specific impact point (for instance, the habitability of a region for a certain type of animal);
- the *successive, incremental* impacts of a single impact factor over a timespan that may include many successive projects in a particular region (for instance, a series of distinct actions of *chemical pollution* occurring years apart from each other may each contribute to the accumulated pollution of a watercourse).

For example, the introduction of invasive species would have potentially catastrophic impacts on the ecosystems of the Rovuma Basin and its surroundings, yet these impacts would be exacerbated by the cumulative impact associated with climate change.

As another example, the actual impact that, say, a species of fish will experience arises from the *combination* of all deleterious impacts (for instance: chemical pollution, acidification of seawater, temperature rise, and acoustic pollution) on the fish. Whereas each of the four impacts may be assessed as a 'moderate' impact when viewed on its own, the combination of all four 'moderate' impacts may be fatal to the fish.

Cumulative impacts cannot be accurately assessed by separating them in silos.

[42] *IFC, (2013)*

The contribution of the gas projects to climate change

"All of the internationally produced global temperature datasets show that 2024 was the hottest year since records began in 1850. Humanity is in charge of its own destiny but how we respond to the climate challenge should be based on evidence", Copernicus Climate Change Service.[43]

Comparative Project Parameters

For each of the four Rovuma Basin LNG projects, the table below shows: estimated volume of gas reserves; volume of gas formally stated to be extracted; greenhouse gas (GHG) emissions reported in the EIA; and the end-use Scope 3 emissions (emissions generated from the end-use combustion of the LNG produced from the projects; classified as Scope 3 Category 11 emissions).

Project Name	Reserves*	Extraction volume**	GHG emissions declared in EIA	Scope 3 emissions based on extraction volume
	[m^3 gas]	[m^3 gas]	[Gt CO_2e]	[Gt CO_2e]
Mozambique LNG[44]	1841 billion	1473 billion	0.30	2.86
Rovuma LNG[45]	2407 billion	616 billion	for Moz-LNG and Rov-LNG combined	1.20
Coral South FLNG[46]	450 billion	116 billion	0.004	0.226
Coral North FLNG[47]	[Coral field]	122 billion	0.027	0.236

Conversions to consistent units by CA Engelbrecht – using 1.942 kg CO_2e per m^3 of natural gas burned

* The actual extent of natural gas reserves in the Cabo Delgado concession areas (Area 1 and Area 4) is not known with high accuracy. It is difficult to quantify actual gas reserves in a seismic target.[48] Consequently, the extents of the gas reserves referred to should be regarded as approximations.

** The extraction volume calculated over the project lifespans of 25 years, as stated in the EIAs.

The formally stated extraction amounts could feasibly be exceeded if any of the projects is expanded beyond current formal projections. The above calculations do *not* include contributions from leakage. The emissions in the final column are therefore only a lower bound on the actual emissions that could accrue from one or more of these projects.

Projected contribution to climate change impacts

Over their lifetimes, the gas extraction projects in the Rovuma Basin – operational and proposed – would contribute significantly to global climate change, with devastating impacts on biodiversity and ecosystem health across the planet, including in Mozambique and the Rovuma Basin itself.

[43] *ECMWF, (January 2025)b*
[44] *Mozambique LNG, (June 2025)*
[45] *ExxonMobil, (June 2025)*
[46] *ENI (May 2025)*
[47] *ENI (May 2025)*
[48] *Grana D (2022)*

According to the ClimateChangeTracker facility,[49] which is based on IPCC calculations, the remaining global carbon budget (RCB) available at the beginning of 2024 to sustain a 50% probability (without considering unproven technologies) of keeping the long-term average global temperature increase below 1.5 degrees C above pre-industrial levels, was about 200 gigatonnes. For an 83% probability of meeting the 1.5 degrees limit, the RCB at the beginning of 2024 was only 100 gigatonnes. More recent calculations indicate that the actual budgets are substantially below IPCC estimates. Based on current emission rates, the actual RCB in June 2025 may be as low as 60 gigatonnes for an 83% probability of meeting the 1.5 degrees limit.[50]

Using the formally stated extraction volumes (as listed in the table above), the combustion of the gas extracted by the four Rovuma Basin projects would consume 7.5% of the remaining global carbon budget – for an 83% chance of staying under 1.5 degrees C – as at June 2025.

If the full estimated reserves of the Rovuma Basin gas fields (as stated in the table above) are extracted, processed and burnt, the Rovuma Basin projects would consume 17% (9.9 $GtCO_2e$) of the 83% RCB, at the very least.

Contributions from potential leakage have not been taken into account in the calculations, and these could increase the impact considerably. The reserve size is always only an estimate as it cannot be determined with great accuracy (for geophysical reasons).

Without significant reductions in emissions, the RCB for the 1.5 degrees target would be exhausted by 2026 in the 83% likelihood case and by 2029 in the 50% case.[51]

It is clear that the Rovuma Basin gas projects would contribute substantially to raising global average temperatures beyond 1.5 degrees C.

The year 2024 was the first year with a global average temperature higher than 1.5 degrees C above the pre-industrial level.[52] The status quo of global energy use and mitigation, according to scientific analysis, indicates that average global temperature will reach at least 3 degrees C above pre-industrial levels by the year 2100.[53] This is considered a conservative figure, and eventual warming is projected to be well above 3 degrees C when self-sustaining feedback loops are factored in.[54] The impact on human societal structures is difficult to quantify but would be severe.[55]

Early warnings

The estimates of emissions from operations are potentially flawed. CS-FLNG is indicated to be producing emissions seven times higher than the estimates in its EIA. In 2025, the civil society organisation ReCommon revealed evidence of excessive flaring at Coral South FLNG that was not adequately reported by project operator ENI.[56] Technical analysis of satellite data showed that thermal emissions were associated with potential flaring incidents. Flaring is the process of burning off excess gas that is extracted, along with other hydrocarbons, and has a massive impact on climate, the environment, and human health.

[49] *Smith C, et al, (2024)*
[50] *Lamboll RD et al. (2023); Rogelj J and Lamboll RD (2024)*
[51] *Smith C, et al, (2024)*
[52] *ECMWF, (January 2025)a; ECMWF, (January 2025)b*
[53] *Fletcher C et al. (2024); Climate Interactive, (2024); IPCC, (2023)*
[54] *Hansen JE et al, (2023),* op. cit.
[55] *Kemp L et al, (2022)*
[56] *Ogno & Pastorelli, (2025)*

The environmental impact assessment for CS-FLNG estimated emissions at 150,000 tons of CO_2e per year, and assesses this as of “negligible” significance. The EIA does not estimate emissions from flaring, and also excludes Scope 3 emissions. However, between June and December 2022, indications are that CS-FLNG flared 435,000 m^3 of gas, with emissions totalling 1,1 $MtCO_2e$.

In January 2024, the project saw a 22% decline in production, due to equipment failures. On 13 January 2024 alone, flaring was estimated to have burnt 6,000 m^3 of gas. Other operational failures since the project began are indicated by the under-reporting of the number of LNG carriers that had loaded cargo, raising suspicion that they had been carrying partial loads. Partial cargoes reduce ship stability, and are permitted only in exceptional circumstances.

When asked about the potential flaring at its Annual General Meeting in May 2024, ENI stated “They were limited to the initial testing phase and occasional system restarts”. The company claims to be compliant with international standards. A statement by Portuguese company GALP, a partner in the project consortium at that point, drew attention to this spike in emissions in its 2023 sustainability report prepared for the Climate Disclosure Project (CDP) (In 2024, GALP sold its shares in the project consortium.)

Natural gas is a fossil fuel

New gas exploration is often premised on the concept that natural gas is a transition fuel, and that it is viable to remove carbon dioxide from the atmosphere

The concept of natural gas as a "transition fuel" has been debunked by many studies.[57] The analyses of empirical studies of leakage rates show that the use of natural gas actually *increases* carbon emissions compared to the use of other fossil fuels. A key factor that has created the (false narrative that natural gas is a transition fuel is a severe underestimation of actual methane leakage from gas sources, including offshore gas wells.[58]

The use of natural gas has resulted in dramatically increased global methane emissions.[59] One of the best routes for slowing the rate of global warming is to reduce methane emissions, and there should be clear benchmarks for reducing the production and use of natural gas.

An important theme in discussions of gas exploration is that industry climate targets are often built on the belief that carbon dioxide can be removed from the atmosphere.[60] The heating scenarios adopted by the IPCC have incorporated this concept.[61] Under this hypothesis, in order to avoid triggering irreversible tipping points in the Earth system, up to 30 gigatonnes of carbon dioxide would need to be removed from the atmosphere each year.[62] Notwithstanding decades of development work, the current rate of carbon dioxide removal is practically zero, at only 0.002 gigatonnes per year.[63] Given geological, techno-economical, and geographical realities, it is unlikely that carbon removal mechanisms would ever be able to exceed a rate of 6 gigatonnes per year.[64]

[57] *Howarth RW, (2019)*; *Kemfert et al. (2022)*; *Achakulwisut et al. (2023)*
[58]*Gordon D et al, (2023); Riddick SN & Mauzerall DL, (2023); Riddick SN et al, (2024)*
[59] *Howarth RW, (2019)*
[60] *Iyer G et al, (2021); IPCC Factsheet, (2022); Schleussner C-F et al, (2024)*
[61] *IPCC, (2023)*
[62] *Zhang Y et al, (2024)*; *Fuhrman J et al, (2025)*
[63] Oxford Net Zero, (2024)
[64] *Zhang Y et al. (2024)*

Limiting global warming to the 1.5 degrees C threshold could *only* happen *if* fossil fuel combustion were scaled down extremely rapidly – on a time scale of a decade or less – *and* if that happened in conjunction with a number of actions, such as: extremely rapid electrification of transport, industrial, and domestic energy; immense acceleration of ecosystem repair and protection; a major shift to plant-based diets; and substantial increases in energy efficiency.[65] None of these vital interventions is being pursued globally at an adequate scale.

Absolute emission reductions must be prioritised. It is not viable to build any new fossil fuel extraction projects if global temperatures are to be kept within manageable bounds.

The impact of climate change on the gas projects

Major elements of Earth's climate are shifting[66] and one key feature of these shifts is the accelerating worsening of extreme weather events. The intensity and frequency of tropical storms and cyclones in the Indian Ocean will increase substantially in the immediate term as well as in the medium and long term.[67] Substantially greater physical forces will impinge on infrastructure during such storms, and engineers have no reliable past experience to use in designing more robust infrastructure for these eventualities.

A detailed study[68] of FLNG installations, which did not take account of exacerbated sea storms and cyclones in the Mozambique channel, states: "Overall it is concluded that the current code provisions do not result in safe design of the stationkeeping system for permanently manned installations in a tropical cyclone environment".

The construction of gas wells in a perilous future marine environment is very risky (hurricanes Katrina and Rita destroyed 113 marine oil platforms in the Gulf of Mexico).[69] Few studies have examined this risk in detail: "There is a lack of comprehensive risk assessment capable of assessing the risks caused by climate change and accurately identifying and reducing vulnerabilities of oil and gas infrastructure located in coastal and offshore regions".[70]

Chemical impacts

Studies of the impacts of chemical pollution resulting from the extraction of natural gas from the ocean floor are still uncommon. The most concerning chemical pollution impact is from gas and gas condensate spills from the wells and pipelines. Given present uncertainties, and the indications of substantial harmful impact that are already emerging, it is prudent to view chemical pollution as a potentially severe hazard to the marine ecosystems in the vicinity of gas wells, and to account for this appropriately in risk assessments.

Chemical Impacts Offshore

65 *Boehm S et al. (2023); IPCC, (2023)*
66 *Ripple WJ et al, (2022)*; *Ripple WJ et al, (2024)*; *Richardson K et al. (2023)*; *Hansen JE et al, (2023)*
67 *Pérez-Alarcón et al. (2023); Thompson C et al, (2021)*; *Tridaiana S & Marzuki M, (2023)*
68 *Stanisic D et al. (2019)*
69 *Dong J et al. (2022)*
70 *Dong J et al. (2022)*

Two main constituents of chemical pollution are associated with two sources of leakage from gas extraction wells: the gas itself, and the gas condensates. Of these, the gas condensates have the greatest impact on ecosystems.

Methane leakage from offshore gas wells is severely underestimated.[71] Leakage occurs through several pathways, including corrosion, damage caused by external loads, fatigue damage, extreme weather events, material defects, weld-seam defects and other forms of system failure.[72] The severity of gas leakage from subsea wells is also dependent on the type of equipment used to extract and transport the gas.[73]

It is difficult to accurately model the impact of condensate leakage. For example, lower concentration over a longer time could be more toxic than higher concentration for a short time, but it is difficult to it is difficult to model the concentration, and condensate is also not visible.[74] Gas condensate could linger for very long periods below the surface, in contrast to crude oil,[75] and the toxic effects could be devastating. Once it dissolves into seawater, it is removed mainly by microbiological processes that can take months to years.[76]

Research on the toxic effects of gas leakage on marine organisms is still sparse and further research is urgently needed; however, the known toxic effects on certain organisms indicates that there will be a range of severe negative impacts on a range of marine life forms.[77] Even if infrequent, spills and uncontrolled releases of petroleum substances – including natural gas and associated condensates – pose potentially significant risks to tropical ecosystems of high ecological value.[78]

A pioneering study[79] indicates that general degradation of local ecosystems occurs as a general result of both oil and gas extraction in marine environments, even without considering the added impacts of leakages and blowouts, stating: "The underlying changes in community composition are driven by loss of sensitive species, loss of larger organisms, declining abundance, and dominance of opportunistic species. These are typical indications of ecosystems under disturbance".

A study on the toxicity of gas condensates from an operating marine gas well found significant genetic effects on sponge species and noted hydrocarbons as “contaminants of concern in tropical ecosystems”.[80] A study of the impacts of impacts of gas condensate and crude oil on copepods found gas condensates to have a two-times higher toxicity effect than crude oil and warns that impacts to copepods could affect the entire pelagic ecosystem.[81]

An important strategy to help protect coral reefs is to minimise additional local stressors, and understand and respond to the risks of pollution events.[82]

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[71] *Riddick SN & Mauzerall DL. (2023)*
[72] *Li X et al. (2016)*
[73] *Muttitt, G,* (2024)
[74] *Reich DA,* (2024)
[75] *Chen L et al. (2019)*
[76] *Muttitt, G,* (2024)
[77] *Paquin PR et al. (2018); Luter HM et al. (2024)*
[78] *Negri AP et al. (2021)*
[79] *Chen Z et al. (2024)*
[80] *Luter HM et al. (2024)*
[81] *Velasquez X et al. (2024)*
[82] *Negri AP et al. (2021)*

Recent studies have expressed the need for reliable data and also proposed modelling methodologies that could predict the spread of gas condensate in marine environments.[83] A complicating factor is that each well would have its own particular composition of gas and condensate, which makes it difficult to model leakage rates before the actual well has been opened.[84]

Gas reservoirs often also include a percentage of water, which is abstracted with the gas. During the LNG production process, this water is separated from the gas, treated, and discharged into the sea. This separated water is called *produced water*, and can contain traces of inorganic and organic compounds. Even if the produced water is treated before discharge, it can still have an impact on seawater quality. Other sources of water pollution include drainage water from the deck and machinery space, bilge water, desalination brine and domestic waste water. All these sources will be treated on board before discharge, but may still contain some dispersed and dissolved hydrocarbons and organic matter.

Ongoing operation of the gas projects would be accompanied by pollution from shipping moving to and from the FLNG plants, as well as shipping moving to and from the shore-based LNG plants. It is to be expected that there will be leakage of fuel from ship engines and further pollution from materials being dumped overboard.

The technical procedures of at-sea transfer of LNG from FLNG terminals to LNG carriers are still under development. In addition, the severity of the impacts of extreme weather events on the risk of vessel collisions is not yet understood. The LNG offloading process from FLNG to LNG carrier can be considered a high-risk operation as it occurs in an unstable and sometimes hostile environment.[85] The risk and impact of potential collisions between LNG carriers and FLNG terminals cannot be dismissed because of the small distance between the vessels required for LNG transfer.[86]

Normal operations will also release nitrogen oxides (NOx) and sulphur dioxide (SO_2) into the atmosphere, as well as carbon monoxide (CO) and particulate matter. These substances are expected, according to the gas project EIAs, to disperse into the atmosphere without immediate hazard to workers on the vessel. Flaring increases the concentrations of these gases released into the atmosphere. The use of gas turbines and diesel generators during operations will release greenhouse gases, primarily CO_2, into the atmosphere.

Chemical Impacts Onshore

Onshore, the construction and operation of the LNG plants will release harmful gases, especially carbon monoxide, nitrogen oxide, nitrogen dioxide, and volatile organic compounds (VOCs), which can cause headaches, coughing, dizziness, respiratory illnesses, and irritation of skin, eyes, nose, and lungs. In addition, the intended airport would result in severe noise and air pollution.

The onshore LNG plants and pipelines would be at risk of leaking methane and other chemical components in the raw natural gas, and would be producing water with heavier hydrocarbon fractions.

[83] *French-McCay DP et al. (2023); Negri AP et al. (2021); Parkerton et al. (2023)*
[84] *Reich DA,* (2024)
[85] *Hu J et al. (2021)*
[86] *Abdussamie N et al. (2018)*

Impacts of alien invasive species

The introduction of alien invasive species (AIS) from ships would have irremediable and immense detrimental impacts on the marine ecosystems of the Rovuma Basin. Gas project operations would include frequent ongoing marine traffic transporting LNG to market destinations, with up to 15,000 ship visits to the floating plants and Palma Bay expected over the course of the project lifetimes. In the absence of strictly policed mitigation protocols, ballast water released into the Mozambique Channel will represent a great threat to the marine biodiversity and ecosystems of the Rovuma basin as well as along the coastline.

Ships take on ballast water, usually near shore, to provide stability and improve their manoeuvrability. This water is usually released at distant locations in exchange for cargo loads. This means that ships enable the migration of AIS to shorelines across the oceans.

AIS have resulted in profound global ecological change, and could cause further severe consequences, including the disruption of ecological processes that provide food and economic benefits.[87] They have significant impacts on tropical marine ecosystems, specifically seagrass beds, coral reefs, and mangrove forests,[88] which are major habitats in the Rovuma Basin. These impacts include displacing endemic species and introducing new diseases that damage the health of the systems.[89] They are a major driver of the severe decline of marine vertebrate populations over the past decade,[90] and their introduction into ecosystems is considered one of the biggest ecological threats for aquatic systems.[91] In marine habitats, once AIS become established, it is nearly impossible to eliminate them.[92]

The Rovuma Basin region is highly vulnerable to AIS.[93] Anticipated traffic to the gas projects would arrive from all corners of the world, meaning there would be a compounding effect of multiple populations of AIS impacting on the local ecosystems. The vulnerability of the Rovuma Basin area indicates that the cumulative impact of multiple invasive populations could be catastrophic. The impact to ecosystems will not be limited locally.

Acoustic impacts

Because of the myriad ways in which marine organisms use sound signals, acoustic pollution associated with marine gas exploration and project operation has major impacts on marine ecosystems. The projected acoustic impact of the Rovuma Basin gas projects can be confidently stated to be severe. The Precautionary Principle urges caution until there is better certainty and understanding about the acoustic impacts of deep-sea gas extraction.

Marine habitats have intricate soundscapes because marine organisms use sound signals for important survival functions such as communication, navigation, reproduction and protection.[94] Introducing sounds into the ocean that are not within the normal range of marine creatures is

[87] *Mack RN et al. (2000); IMO, (2025)*
[88] *Alidoost Salimi PA et al. (2021)*
[89] *Alidoost Salimi PA et al. (2021)*
[90] *Gjedde P et al. (2024)*
[91] *Molnar JL et al. (2008)*
[92] *Simard N et al. (2024)*
[93] *Gjedde P et al. (2024)*
[94] *Duarte CM et al. (2021)*

disturbing and confusing in the same way that flashing bright lights would be for creatures living on land.[95]

Anthropogenic noise from both infrastructure and shipping has significant short-term physiological and behavioural impacts on marine biodiversity, and some of the short-term impacts of acoustic pollution on marine ecosystems are well studied.[96] The impact on invertebrates is significant[97] and includes high rates of injury and death of zooplankton from internal injuries and cellular damage.[98] Shipping noise disrupts traveling, foraging, socialising, communicating, resting, and other behaviours in marine mammals, and also impacts fish behaviour and invertebrates.[99] Without a good understanding of the full scope and extent of acoustic impacts, it is not possible to assess the harm that is caused with accuracy.[100]

There is a substantial lack of data on and understanding of the full severity and scope of these impacts, specifically the long-term and cumulative impacts of different sounds and sound levels (generated over different periods of time) on the behaviour and survival of individuals and populations. Further research is needed, specifically on the response of fish species to different sounds under different conditions.[101] The gaps in information make it impossible to reach clear conclusions on the projected impacts of acoustic pollution on the physiology or behaviour of animals.[102]

Offshore structures such as drilling platforms produce low frequency noise through their dynamic positioning systems – i.e., the propellers and thrusters used to maintain their position.[103] Marine drilling produces high-intensity sound that affects marine mammal behaviour and can have very significant deleterious effects on plankton.[104] Operational gas wells generate noise mainly in the range 0.01 kHz – 1 kHz, which overlaps with the hearing range of nearly all marine fauna.[105]

Severe acoustic impacts will result from normal FLNG vessel operations. Platform supply vessels and anchor handling and support tug vessels generate noise levels up to 178 dB. The FNLG thrusters generate sound levels up to 189 dB. Substantial and even harmful impacts may occur to a broad range of marine life in the presence of such high sound intensities. Two technical points should be noted here. First, the quoted dB levels are as measured 1 m from the source. Sound intensities fall off with the square of the distance. Second, an increase of 10 decibels represents a tenfold increase in sound intensity. Combined, these two points mean that a formal sound level of 189 dB (at 1 m from source) will decline to 129 dB at a distance of 1 km from the source and to 109 dB 10 km from the source. Thus, even at many kilometres from the source, the projected sound intensities described here remain very high.

Climate change could also increase acoustic stresses because it could increase geophony levels – the levels of natural, non-biological sounds such as wind, waves and rain.[106] Change in ocean acidity could also result in a noisier ocean, because of a reduced ability of the waters to absorb sound of frequencies lower than about 10 kHz. The hearing range of almost all marine organisms

95 *Duarte CM et al. (2021)*
96 *Duarte CM et al. (2021)*
97 *Duarte CM et al. (2021)*
98 *Weilgart, L (2018)*
99 *Duarte CM et al. (2021)*
100 *Morelle-Hungría E et al. (2023)*
101 *Popper AN and Hawkins AD, (2019)*; *Rojano-Doñate L et al. (2023)*
102 *Popper AN and Hawkins AD (2019)*
103 *Duarte CM et al. (2021)*
104 *Prosnier L et al. (2024)*
105 *Duarte CM et al. (2021)*
106 *Duarte CM et al. (2021)*

lies below 10 kHz, which means that any long-distance sound that is created underwater affects almost all marine life.[107]

It is also unknown which keystone species[108] in the Basin may be fatally impacted by the drilling and operation of gas wells. The Precautionary Principle should be applied. Member states of the Convention for the Protection of the Marine Environment of the North-East Atlantic, OSPAR 4, are mandated to adhere to the Precautionary Principle to protect the seas and oceans.[109]

Physical impacts onshore

The installation of very large liquefaction plants and support structures onshore will cause significant impacts on the terrestrial and coastal ecosystems and biodiversity of the Afungi Peninsula, including on soils, bodies of water, vegetation, and animal life. There will also be significant impacts on non-tangible components: air quality, visual appearance, and sound pollution. The integrated impact of these sub-compartmentalised impacts will result in serious and irreparable harm to terrestrial ecosystems in the region.

Vitally important topsoils will be destroyed by the digging, clearing, excavation, and compaction of the local terrain required for the major engineering works required by the projects. Water bodies will either be lost or significantly diverted, coupled with water extraction for engineering purposes. Water tables, drainage processes, and delicate wetland and estuarine dynamics will also be significantly disturbed and/or destroyed.

The infilling of wetland areas will generate considerable impacts on the populations or even survival of many larger animal species, including snakes and other reptiles, fish, small mammals, and birds. A key source of concern is the unpredictable loss of keystone species, which could cause an entire ecosystem to collapse or be severely compromised. Sediments spread by the engineering processes could also suffocate smaller animals (crustaceans, molluscs, and micro-organisms like freshwater plankton).

The loss of topsoils, destruction of wetland and estuarine areas, and changes in water quality as a result of the projects could cause the demise of critically important tree communities, especially mangroves, and other important vegetation in the area.

Physical impacts in the marine environment

The drilling of wells and the installation of pipeline networks in the ocean will impact the near-shore and the deep-water marine environment. The full impact of physical pollution related to deep ocean gas activities is not known, and therefore meaningful assessments cannot be made. The established vulnerability of the reef systems and other ecosystems in the project region indicates that extreme care should be taken to avoid physical impacts. The Rovuma Basin gas project EIAs do not assess physical impacts on the marine environment adequately.

The area that would be affected by Moz-LNG[110] includes reef structures in the deep-water environment – up to 2,3 km deep – in waters that support a large number of marine mammals, fish

[107] *Duarte CM et al. (2021)*
[108] *Davic RD (2003)*
[109] *Morelle-Hungría E et al. (2023)*
[110] *M-ESHIA, Page 31*

species, turtles, and sea birds. Impacts would be from drilling, discharge of treated drill cuttings and residual muds, disposal of dredged material, and installation of subsea infrastructures.

Wells are drilled in the ocean environment up to 50 km from the shoreline, and raw natural gas is piped to the onshore LNG plants (trains). Approximately 90 wells (and maybe more) are planned for the four projects together, with 6 each planned for the floating plants, up to 55 wells for Mozambique LNG, and 24 wells planned initially for Rovuma LNG with scope to expand.

Ocean drilling requires placing infrastructure such as anchors and pipelines on the seafloor, which directly disturbs the seabed and increases sedimentation.[111] Offshore infrastructure would be supported with mudmat structures and suction piles, which have extensive footprints on the seafloor around the wells and pipelines. Pipelines create hardened structures which alter the local seabed habitat conditions.[112] For semi-submersible drilling rigs, the spatial impact of anchors on the seabed is typically 1.5 – 2.5 times the water depth of the operation, with 8 – 12 anchors used.

Cuttings or wastes from drill sites are often dumped[113] on the surrounding ocean floor, smothering the benthic organisms. Drilling waste or cuttings will permanently modify the seabed, affecting deepwater reef structures with corals and other sessile fauna.[114] Drilling waste is known to be toxic to aquatic organisms,[115] but the impacts on deep-sea ecosystems is largely unknown.[116] New studies are necessary to address the gaps in understanding about the toxicity and impacts of drilling wastes at different trophic levels of the food web.

Turbidity, which refers to the suspension of fine sediment in the ocean water that results from the mechanical cutting required to make the trenches, also impacts marine ecology. The major artery pipeline passing south of Tecomaji Island and near Rongui Island, would require massive dredging from the islands shoreward. The projects intend that the reefs around Cabo Delgado Peninsula to the north of Palma Bay will also be dredged.

Dredging for the pipeline corridor for Moz-LNG (running from the gas fields to onshore LNG plants) is expected to generate 6.4 million cubic metres of waste. Dredging in Palma Bay would produce about 12 million cubic metres of waste. For Coral North, each well could result in 1,350 cubic metres of cuttings and about 45 cubic metres of low-toxicity oil-based mud, which is intended to be treated and disposed of on land.[117]

The FLNGs require anchoring. As anchors are placed, they drag along the seabed, damaging structures and habitats that support seafloor organisms. Coral communities will be impacted directly through both physical impact and increased sedimentation, along an estimated 100 m wide corridor. There is particular concern about deep sea biogenic habitats – habitats created by plants and animals such as corals and sponges – because of their fragility and low resilience to physical forces.[118]

[111] *Cordes EE et al. (2016)*
[112] *Cordes EE et al. (2016)*
[113] *Lelchat F et al. (2020)*
[114] *Marappan S et al. (2022)*
[115] *Costa LC et al. (2023)*
[116] *Lelchat F et al. (2020)*
[117] *CN-EIA,Section 7.5.2*
[118] *Cordes EE et al. (2016)*

Key flaws in the Rovuma Basin gas project EIAs

Broad overview of common flaws across the gas project EIAs

(Specific details of the flaws summarised in this introductory overview are presented in the sections that follow).

Well-established guidelines have been developed for what an EIA should contain.[119] The critiques of the Rovuma Basin gas project EIAs highlight important deviations from commonly accepted guidelines.

- There are significant deficiencies in the establishment of a biodiversity baseline for the Rovuma Basin and Afungi Peninsula and surrounding regions, and notably no independent, scientifically appropriate, and comprehensive survey of deepwater coral or other ecosystems. Neither are such surveys to be found in the published literature. This indicates that the potential impacts on the region are currently poorly understood. There is therefore no foundation for reliable conclusions about the impacts of gas development on the region, and especially no basis for minimising potential impacts.

- None of the four EIAs makes any mention of Scope 3 greenhouse gas emissions from the burning of the LNG produced. If these emissions are ignored, total GHG emissions would be vastly under-represented, which would hinder the development of effective strategies to reduce emissions.[120] Recent prominent court cases have recognised the need to include Scope 3 GHG emissions, resulting in judgements against companies who had failed to do so.[121]

- Cumulative impacts are understated and incompletely formulated, and the impacts are presented in a way that appears to evade a proper assessment of the severity of cumulative impacts on biodiversity and ecosystems.

- Given the immense impact that the introduction of alien invasive species could have, the impact of AIS is strikingly under-represented in the EIAs.

- Chemical impacts are generally understated or even misrepresented. These impacts are assessed as minimal, yet the rationale for this is contradicted by published studies, such as that by Roberts et al.,[122] which discusses the impacts of desalination plant discharges on marine life.

- The physical impacts of gas project activities on the seafloor are assessed as insignificant, whereas the established vulnerability of the reef systems and other ecosystems in the project region indicates that extreme caution should be taken to avoid these physical impacts.

- Acoustic impacts are understated and limited in scope, and the cascading effects of acoustic impacts on the behaviour of keystone species are ignored.
- The acoustic impact from marine traffic transporting LNG from the project sites to markets on a continuous basis is not considered at all.

- Proposed mitigation measures proposed often include the phrase “to the extent practical”, which creates a loophole for avoiding mitigation action. There is no established mechanism for monitoring environmental impacts, or the effectiveness of mitigation measures, in the deep ocean environment of Mozambique.

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[119] *Morrison-Saunders A, (2023)*
[120] *Klaver F, et al. (2023)*
[121] *UK Supreme Court, (2024); FoEEWNI, (June 2024); Climate Change Litigation Database, (2023)*
[122] *Roberts DA et al, (2010)*

Flaws in the EIAs for Mozambique LNG and Rovuma LNG

The Mozambique LNG and Rovuma LNG projects initially conducted a joint EIA (RM-EIA) in 2014. The two projects share the land rights to the Afungi gas site, allocated for the onshore facilities for their projects. Later, each project conducted an updated amendment to the original EIA, while still relying on the original 2014 EIA as a basis.

Flaws in methodology

The following flaws in methodology are evident in the 2014 RM-EIA:

- The RM-EIA suffers from numerous omissions that limit its relevance and applicability, especially the failure to construct a baseline of biodiversity across all ecosystems existing in the areas affected by the projects.
- The RM-EIA includes several instances of misrepresentation. In many instances the narrative appears to be making a reasonable point, but the conclusions reached are unjustifiable.
- In some instances, the RM-EIA is self-contradicting or simply confusing.
- The RM-EIA frequently evades the statutory responsibility of the project owners to conduct thorough and scientifically sound baseline surveys of all relevant components of local ecosystems by inserting the words "to the extent practical" (sometimes "to the extent practicable").
  - For example, the RM-EIA states that the project would "survey all locations for subsurface infrastructure by ROV and avoid to the extent practical areas of high and low-relief deepwater reef structures". Yet no such survey was conducted, and instead the nature of reef structures was assessed using a limited sample of remotely operated vehicle (ROV) footage that was obtained during the exploration phase. The omission of a thorough survey that would have been able to inform mitigation measures makes it clear that the phrase "to the extent practical" has been used to evade statutory responsibility.
- The RM-EIA acknowledges that statutorily required work has not been conducted in many instances, in particular with regards to the requirements for a thorough and satisfactory biodiversity baseline.
- The RM-EIA includes accounts of poor practice in the proposed execution of the projects, revealing flaws in the operational design of the projects that should have been flagged by the EIA.
- Rigorous assessment has been compromised due (presumably) to the short time frame allocated for the EIA. The constrained timeframe of the EIA itself limits the scientific validity of the baseline studies, negating the purpose of conducting the EIA in the first place.
- The RM-EIA often uses disingenuous ranking methodologies. Ranking measures are nonsensical when scrutinised and seem to be arrived at in ways that favour the gas projects. This skews the final assessment of impact and risk.
  - For example, sand beaches are not as ecologically significant as sea grass beds or coral reef systems in the region affected by the gas projects, yet are ranked equally.
- The RM-EIA makes reference to past impacts on the local environment to justify ignoring further impacts that the gas projects would have.
  - For example, the fact that fishing pressure is high in Palma Bay and the surrounding area is used to justify an assessment of the further impact by the gas project on fish populations and

diversity as of “minor” significance. This is poor EIA practice and runs counter to the general consensus that cumulative effects are of great importance in EIA.[123]

Key Omissions

Examples of omissions that render the RM-EIA of limited applicability:

- A marine ecology survey was not conducted in the deep-water environment and no independent scientific studies were conducted for deepwater species. The ecology baseline that is offered is deficient as it is based on secondary data from surveys conducted for exploration of gas fields or commercial fishing operations. It is highly questionable for an EIA analysis to rely on project contractors to provide an overview of the marine ecology in the region; this casts doubt on the objectivity of the report.
- The review of reefs in the offshore area was limited to selective ROV footage that was obtained as part of the gas exploration work. Baseline studies of the natural environment should be conducted by skilled specialists with that purpose in mind; reliance on video footage that was taken for different purposes is inadequate for a scientific baseline study.
- A scientifically sound survey of the fish biodiversity in the deep-water environment is lacking. This constitutes a serious omission for the baseline study.
- There is no scientifically sound fish survey for Palma Bay; the RM-EIA simply assumes the area has similarities with the coral reef and seagrass biotopes to the south of Palma Bay.
- Data on coral reef and seagrass fish species is mainly based on data from the nearby Quirimbas archipelago that is more than a decade out of date. It is unknown whether these species still occur in the region, or whether others have in-migrated due to changing ocean temperatures, acidity and fishing pressures.
- The project impact on the nearby mangroves to the east and west of the Afungi site is assessed based on information from the engineering team. An objective scientific analysis is required.
- A terrestrial biodiversity baseline is lacking, for example:
  - The RM-EIA provides only a "snapshot" of terrestrial avian species on a few days of the year. A thorough survey would have assessed avian populations at frequent intervals during the year and across successive years to account for migratory patterns among birds.
  - Very poor scientific sampling for herpetofauna (reptiles and amphibians) was conducted in this region. This is ascribed to a lack of resources for the EIA. It can be considered a dereliction of duty that the required time to conduct an appropriate survey was not budgeted.
  - There is insufficient detail on the methodology used to assess herpetofauna. The M-ESHIA states that surveys and monitoring recorded 40 amphibians and 61 reptile species in the project area. It is not clear how the numbers were established, or how the species were identified. A thorough baseline would require a formal ecological species field investigation method, investigation across seasons, in dry versus wet years, and during El Nino or other global climactic events.
- The assessment of air quality impact considers only the combustive sources of air emissions from the LNG trains, and only some oxides.
- There is no consideration of fugitive emissions of methane along the transport routes.
- The impact of groundwater pollution and abstraction on the local population and ecology is not revealed.

[123] *IFC, (2013)*

Illogical conclusions

Examples of misrepresentation in the RM-EIA where the narrative appears to be reasonable but the conclusions are not justified:

- Assumptions are made that marine mammals would simply avoid acoustic pollution generated by the project, whereas the cumulative impact of long-term behavioural change among these mammals is not assessed.
- Approximately one third of the project footprint area consists of critically important wetlands, yet the impact on wetlands is assessed as only "moderate".
- Wastewater discharges from desalination and domestic sewage treatment plants are considered to have “negligible or undetectable short-term effects on marine ecology and/or marine ecological processes". This contradicts sound scientific knowledge on the harm of wastewater, and the adverse impacts of desalination plants, on marine ecology.[124] The cumulative impact of 25 years of regular short-term discharges could be immense.

The RM-EIA, argues that the mitigation of impacts should be offset against promised or perceived economic gains linked to the project. This counters the very intent of an EIA by arguing that the development would somehow improve the physical environment.

Cumulative Impacts

- The RM-EIA assesses each class of impact separately, which fragments impact assessment. This tactic allows distinct impacts to be assessed as “moderate” or “minor” by ignoring their cumulative impact.
- A coral reef or seagrass system suffers seamlessly from the combined impacts of chemical pollution, drill waste and cuttings, suspended solids, dredge sediment deposition, ocean warming and acidification, alien invasive species, keystone species loss and acoustic pollution. These impacts occur more or less simultaneously and need to be assessed as a whole, not compartmentalised.
- No such assessment of cumulative impact is present in the RM-EIA, nor in the 2020 update.
- The approach to cumulative impacts in the M-ESHIA subverts the purpose of cumulative impact assessment (CIA) by arguing that the existing impact of past projects and activities justifies a lower risk assessment for new impacts of the gas activities.

Climate Change

- The RM-EIA states emissions from operations to be 12.15 Mt CO_2e for the LNG processing activities, with the carbon footprint estimated in accordance with design options at the time and subject to change:
- It includes no calculations, assumptions are not listed, the emissions factors used are not listed, and accounting for fugitive leaks is not described.
- Scope 3 emissions are not considered.
- The EIA does not indicate a baseline methodology but instead uses a vague discussion of general principles of GHG accounting.

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124 *Roberts DA et al, (2010*)

Chemical impacts

- In assessing air quality impacts from the LNG trains, the RM-EIA considers only the combustive sources of air emissions from the LNG trains, and only the oxides NO_x and SO_2. It lacks consideration of fugitive emissions of methane along the transport routes (from the wells to the liquefaction plant) and of volatile organic compounds (VOC) emanating from liquid effluents, pools or leaks. This is an LNG plant dealing with both natural gas processing and fugitive leaks of methane and condensate, and produced water with heavier hydrocarbon fractions. Consequently, VOCs will be a component of local air emissions and should have been included in the assessment.

- Different types of VOCs accompany natural gas reservoirs and most will evaporate from the transport routes or storage reservoirs and escape into both the marine and atmospheric environments.

- The RM-EIA states that there would be no chemical loss to the marine environment during normal production operations. Hazardous chemicals such as monoethylene glycol (MEG) are injected into gas pipelines to improve flow. MEG and methanol are both hazardous chemicals posing threats to marine life. There is no guarantee that these chemicals will be isolated from the "produced water" or wastewater, and there is a risk that these chemicals will be released into the ocean during operational procedures. Unless it can be guaranteed that there is a 100% separation of water from MEG/methanol, there will be residue present in the produced water and salts after separation, with consequent contamination of the ocean or coastal area where the produced water is dumped. It is not stated that there will be no loss of MEG or injection chemicals when the produced water and brine are separated from the MEG and slag. The M-ESHIA states that these chemicals won't contaminate the ocean but does not explain how it can be guaranteed that no spillage will occur.

- The bioaccumulation of toxins is not considered to be an impact, in relation to benthic creatures consuming sediments contaminated by hydrocarbons, and the resultant impact on the health of fish that people consume is considered to be "negligible". This is a misrepresentation that contrasts scientific understanding of bioaccumulation in marine environments. It is illogical to argue that only benthic organisms will be affected by the toxic sediments, as these organisms are a food source for many others, including humans.

- Wastewater discharges from desalination and domestic sewage treatment plants are considered to have "negligible or undetectable short-term effects on marine ecology and/or marine ecological processes". This contradicts sound scientific knowledge on the harm of wastewater, and the adverse impacts of desalination plants, on marine ecology.[125]

Alien Invasive Species

The RM-EIA refers to International Maritime Organization regulations that "ballast water must be exchanged mid-ocean". However, mid-ocean ballast water exchange is not a condition imposed for ships involved in this project, and there is no indication that it would be possible to monitor whether such ballast water release has been conducted.

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125 *Roberts DA et al, (2010)*

Acoustic impacts of dredging and drilling

- The RM-EIA analysis can be considered to be severely deficient with regards to the acoustic impacts of dredging activities in Palma Bay. It cherry picks the science, citing two conflicting studies and then relying on the study that references zero impacts. A full scientific analysis with underwater acoustic modelling should be conducted.

- The RM-EIA describes the acoustic impact of drilling on marine life as moderate, listing a peak in the frequency range of 125 to 2,500 Hz. It also dismisses the fatal effects of these sound levels on plankton. A full scientific analysis with underwater acoustic modelling should be conducted.

Acoustic impacts from LNG Carriers

The RM-EIA indicates that 10–12 vessels (and maybe more) will be loading LNG from the onshore facilities each week for 25 years (1300 weeks in total). This constitutes a massive acoustic impact.

- The RM-EIA represents acoustic pollution levels incorrectly, and therefore understates the impacts.
- The RM-EIA assumes that marine mammals would simply avoid acoustic pollution generated by the project, whereas the cumulative impact of long-term behavioural change among these mammals is not assessed.

Pipelines

- For the onshore projects, according to the RM-EIA, about 1.1 km^2 of hard metallic structures and interconnecting pipelines will be placed on the seabed. Where it is deposited, the drilling waste will permanently modify the seabed environment. The area is thought to be mainly sand/mud, augmented by deepwater reef structures with corals, tunicates and other sessile fauna. These low to high-relief reefs are vital habitats, particularly for deepwater fish, and reef damage could have important effects on the regional biodiversity.
- The RM-EIA states that the impact of offshore support structures post-mitigation will be "negligible". This is a misrepresentation.

Dredging waste, drill cuttings and turbidity

For the laying of pipelines for Moz-LNG – from the wells on the seafloor to the onshore processing plant –- 6.4 million cubic metres of dredging waste (including drill cuttings and drilling muds) would be generated. The RM-EIA claims that only 1 km^2 of reef structures would be affected and that the impact would be local. However, the EIA also indicates a burial depth of 1 cm as fatal to the benthic community, with impacts expected for periods of 10 to 100 years because of the generally slow growth rate of deepwater reef organisms.[126]

- Simple calculations show that if the total declared volume of waste of 6.4 million m^3 of sediment were distributed to a uniform depth of just over 1 cm – just exceeding the fatal depth for sea floor creatures – it would cover an area of approximately 600 km^2 of the seafloor. That is a much larger area than the entire Palma Bay. If the waste would be covering an area of only 1 km^2, it would be piled up to 6.6 m above the seafloor. It is physically illogical that this would remain in place for any length of time in an environment typified by strong and constant ocean currents.
- With regards to the impacts of treated drill cuttings and residual muds, the prime data source for impact mitigation purposes is composed of ROV (remotely operated vehicle) surveys immediately around the planned drill sites: 8x400 m or 4x500 m explorations conducted at potential drill sites, covering approximately 10 – 20 km^2 in total. This is poor science, given the actual area – hundreds of square kilometres – that would be impacted.

126 *RM-EIA, Chapter 11, Page 11-13*

For the cutting of trenches to accommodate the jetties and other structures as well as an anchorage area, and approach channels, near-shore dredging is conservatively estimated to produce 12.2 million m^3 in volume. The project intention is to dump this waste down the edge of an underwater cliff at the eastern end of Palma Bay, to the north of Tecomaji Island. This would mean that ocean currents would disperse this material and it would eventually spread across a vast area, smothering benthic sea life for an uncertain amount of time into the future.

- The RM-EIA claims that the physical impact of dumping dredge material would be "minor" because of an expected recovery rate of less than 7 years for coral and seagrasses. There is no firm scientific basis for this claimed coral and seagrass recovery timeframe of less than 7 years. A fairly recent study concluded that recovery times of seagrass beds were very variable, and that the majority of seagrass habitats never recovered fully.[127]
- There is no indication of an assessment of the impacts that would result from the use of the deep canyon north of Tecomaji to dump dredge material, which could be severe.
- The M-ESHIA acknowledges that the impact of turbidity on the marine ecology (and on coral reef and coral basement foundations) resulting from dredging between Tecomaji and Rongui islands will be "major". However, it proposes a weak mitigation option and, further, there is no statutory agency responsible for monitoring whether the mitigation measures are adopted.
- Palma Bay is described as a low sediment bay, which indicates the coral, seagrass and fisheries systems are adapted to low sediment loads and low turbidity. Increased turbidity in this bay would have a great impact on the existing ecosystems. The RM-EIA assess the effects of turbidity on marine ecology to be of "moderate" significance, "medium" intensity and "medium" magnitude. It lacks adequate discussion and assessment of the physical impact of the deposition of sediment on top of reefs and seagrass beds. Our assessment is that the levels of impact would be major.

Flaws in the EIA for Coral North FLNG

The following flaws in methodology are evident in the Coral North EIA:

- The CN-EIA relies on subjective measures and assessments to specify the level and intensity of the impacts discussed; these are dependent on the judgement of the assessor and not on standardised objective criteria. This opens up the conclusions reached in the EIA to manipulation, in service of a desired outcome.

- When assessing "probability" in accordance with the ranking scheme in the CN-EIA, the lack of data makes it impossible to assign a reliable score. Given the potential severe consequences of a misjudgement, application of the Precautionary Principle is highly appropriate in assessing probability. There is no application of the Precautionary Principle here.

- The description of "mitigation requirements" in the CN-EIA is subjective. It states that the goal of mitigation is to achieve "acceptable levels" of impact significance. It is not clear what "acceptable" is gauged against. Without an agreed understanding of what is "acceptable" and what is not, the stated aim has no clear meaning. The term "significance" as used in this EIA also has no robust meaning.

Cumulative impacts

The CN-EIA section on cumulative impacts is poorly prepared.[128]

- According to the criteria set out in the EIA, the viability of the project to proceed should be weighed against the cumulative impact on the marine environment. There is no evidence in the EIA that this has been done.
- The CN-EIA attempts to steer away from responsibility for conducting a proper CIA by arguing that ecological thresholds "cannot be identified until they are actually exceeded". The Precautionary Principle advises exercising extra caution when there is uncertainty about thresholds.

[127] *McSkimming C et al. (2016)*
[128] *CN-EIA Section 7.11*

- In its cumulative impact assessment, the CN-EIA appears to evaluate greenhouse gas emissions (GHG) and climate change with reference to marine mammals, sea turtles, and seabirds. There is no mention of other classes of marine life in the Rovuma Basin.
- The CN-EIA ignores – and subverts – one of the main drivers of cumulative impact, namely the combined effect of distinct impacting factors, by only taking an impact into consideration for assessing cumulative impact when it had initially been allocated an impact severity of “medium” or higher. This approach ameliorates the assessment of the combined impact because impacts that are individually assessed to have “low” severity are simply discounted from the combined effect, whereas the combined impacts of multiple impacts could be severe.
- The CN-EIA attempts to direct responsibility for CIA to the Mozambican government, suggesting that integrated planning and mitigation for the gas industry and associated projects should be led by the state. This is not proper EIA practice.

The CN-EIA makes a number of unfounded conclusions. For example, in reference to CN-FLNG and CS-FLNG it states: "Unplanned events that can result in major hydrocarbon spills are a very low frequency event in the oil and gas industry. The probability of two such events occurring simultaneously between the projects considered (and thus generating cumulative impacts) is so low that it can be considered negligible". The assessment of a “negligible” probability here is misleading. Storms and cyclones are key risks to gas projects, and a storm event severe enough to destroy a wellhead at one FLNG could likely cause similar damage at the other, as the sites are within 10 km of each other.

Climate Change impacts

- The climate change risk assessment in the CN-EIA has many errors or misrepresentations of great magnitude.
- In the discussion of the impact of greenhouse gas emissions, only emissions from the construction and operation of the project infrastructure are considered. There is no consideration of Scope 3 emissions.
- The impact of climate change on the project is severely underestimated. It states: "the current and future physical risks to the Project associated with the impacts of climate change have all been assessed as low or negligible". This assessment is not borne out by the projected impacts of a heating planet and heating oceans on the frequency and intensity of extreme weather events.

Chemical impacts

An important flaw in the CN-EIA's spill modelling is that it only considered the dispersal of hydrocarbons on the surface of the ocean, with no modelling conducted on the dispersal of gas condensate below the surface (where it could linger for very long periods),[129] and where its toxic effects could be devastating. In their study, Chen et al. state that "once dissolved in seawater, [gas condensate] is removed mainly by microbiologic processes that may take months to years". It is difficult to accurately model the impact of condensate leakage.

In the CN-EIA, the risk of chemical pollution of the marine environment in the form of petrochemicals (including natural gas and its attendant condensates) appears to have been confined to the risk of a well blow-out. The impacts of leakage of gas condensates is a standard feature of undersea gas wells but was not addressed.[130]

[129] *Chen L et al. (2019)*
[130] *Negri AP et al. (2016)*

The CN-EIA includes no acknowledgment that both natural gas and gas condensates leak from marine gas wells during operations as a matter of course. The associated damage to the marine environment has been specifically addressed by Chen et al.[131] and Luter et al.[132]

The CN-EIA does not evaluate at all the potential impacts of aromatic compounds dissolved in the condensates. A high condensate content would result in contamination of a large volume of water, which creates significant risk of condensate leakage to the health of fish and invertebrate species. [133]

The CN-EIA acknowledges that gas spills could occur if a wellhead explodes, and that the combination of high pressure, the volatile nature of gas condensate, and the difficulties with drilling at depths, poses a high risk of a potential condensate spill into the environment. In contrast, it then assesses a gas condensate spill resulting from a well blowout as of “medium” significance. It downplays the risk associated with an unplanned blowout, indicating that operational controls and response preparedness justify degrading the risk to “greatly reduced”. Accidental blowouts are caused by physical mechanisms that are the result of natural forces in the environment, coupled with possible flaws in engineering or mechanical failures. It would not be possible for "controls" and "preparedness" to counter these extraneous factors.

The CN-EIA[134] includes a simulation of the distribution patterns that would follow a hypothetical hydrocarbon spill, and other discharges, such as produced water and heat.
The impact of once-off (accidental) spills is discussed.[135] A diesel spill resulting from a ship collision was considered to have a low probability of <40% and assessed as having “medium” significance. A likelihood of 40% is not a low probability and it is unwarranted to dismiss the risk of toxic chemical spills that would result from vessel collisions.

In its discussion of the mitigation of the risk of potential collisions between ships and the FLNG plants, the CN-EIA indicates that mitigation mainly corresponds to operational controls to prevent unplanned events from occurring, such as a wellhead blowout, and being prepared to respond if an accident occurs. Appropriate operational controls and response preparedness should be automatic elements of project design and execution, not relegated to "mitigation measures".

Alien Invasive Species impacts

The CN-EIA acknowledges the negative long-term impacts of alien invasive species (AIS) and the risk of introducing them through ballast water exchanges. It assesses the significance of the impact of AIS as “low” and downplays the risk without a firm basis for doing so. This is a serious error. It also assesses the project impact of AIS as “low intensity” because the project-related marine traffic is a small fraction of existing traffic in the Mozambique Channel. As ships employ ballast water to improve manoeuvrability, the release of ballast water when mooring onto the FLNG vessels is likely to occur far more frequently than releases by vessels simply passing through the Mozambique channel en route elsewhere. The assessment of "low intensity" impact is spurious.

Acoustic impacts

The CN-EIA grossly under-represents the acoustic impacts of the project,[136] and fails to apply the Precautionary Principle with regards to acoustic impacts.

The CN-EIA acknowledges that there would be zones, extending several km from noise sources, within which behavioural harassment of marine mammals would occur and that there would be 'corridors' between

[131] *Chen Z et al. (2024),* op. cit.
[132] *Luter HM et al. (2024),* op.cit.
[133] *NJ and JA!, (2024)*
[134] *CN-EIA, Vol 04*
[135] *CN-EIA, Section 7.5.4*
[136] *CN-EIA, Section 7.4*

FLNG stations in which noise levels would remain below significant thresholds. It also states that during standard operation of the FLNG vessel, continuous noise would generate behavioural harassment felt by marine mammals up to 33 km from the FNLG plant.[137] The projected peak intensity for the *Coral North* project is 189 dB. These facts illuminate the deficiencies in the CN-EIA's assessment of acoustic impact; for example, in the following instances:

- The region impacted would encompass practically the entire Rovuma Basin. This is a projection of severe acoustic impact.
- The acoustic impact is considered a temporary impact in the CN-EIA and given a “very low significance rating”. Both of these assessments are illogical, as acoustic impacts related to carrier docking and undocking would be present every week for 25 years.
- The CN-EIA comments on only four of fourteen animal groups known to be affected by anthropogenic noise in the ocean. It lacks an analysis of acoustic impacts on marine creatures other than mammals, fish, and sea turtles. This is an indication of poor attention to impacts on actual biodiversity.

Each of the floating facilities would require the arrival and departure of at least one 300-m long[138] LNG carrier per week, for 25 years.[139] Thrusters needed for docking and undocking can be active for up to 15 hours each time. These vessels can generate noise at levels above 186 dB, and even at low speeds, the noise can exceed 168 dB[140]. Even with attenuation over distance, these are extremely loud noise levels for many marine animals.

[137] *CN-EIA Vol 04, Page AVI.62 Table AVI.F.1*
[138] These are the recently-introduced super-large LNG carriers, loading 170,000 cubic metres of LNG
[139] *CN-EIA Vol 01, Section 4.4.4.2*
[140] *Rojano-Donãte L et al. (2023)*

Recommendations

Financial institutions are responsible alongside the projects they support for any harm caused to ecology and peoples from project activities over the full lifespans of those projects. The investment decisions and policies of financial institutions should prioritise the protection of nature and peoples, and should play a transformative role in the global transition to economies and renewable energy systems that are community driven, peoples-centred and climate and environmentally just.[141]

The oil and gas industry has detrimental social, climate and environmental consequences, often has a detrimental impact on economic development, and is often associated with conflict.[142] These impacts are all evident in relation to the Rovuma Basin gas projects in Cabo Delgado province, Mozambique.[143] Transnational corporations, their subsidiaries, and all entities within their global value chain must be held accountable for violating human rights through their direct or indirect actions.[144] This is particularly important when the company's activities take place in a conflict or war zone or lead to the emergence or intensification of conflict.

Financial institutions already involved in the Rovuma Basin projects must scrutinise the risks posed by the projects, thoroughly assess if there is any benefit to continued involvement, and seek out measures for divesting or withdrawing from these projects. At the very least, financial institutions should demand a full stop to any project infrastructure activities until there is irrefutable evidence that the projects will not cause irreparable harm to Mozambique's peoples, the environment and the economy.

Integrating long-term environmental, social, economic and governance requirements into financing and investment decisions is critical for fostering responsible and sustainable financial practices that address urgent global challenges such as climate change, social inequality, democracy, public participation, and ethical governance. Such policies should be in line with international and regional conventions and national legislation.[145] They should also be based on the Precautionary Principle, or the First Do No Harm Principle.

Financial institutions should uphold and ensure the primacy of international human rights law over any other international legal instruments, including over trade and investment agreements, and place an obligation on the companies and projects they finance to respect human rights and the environment. This should include provisions to ensure liability for harm, including to put into effect adequately and timely repair and compensation when violations occur. They must take into account and address the gendered nature of corporate human rights violations, including their specific and differential impacts on women.[146]

Fossil fuel investments are often protected by investor state dispute settlement (ISDS) provisions, which has led to delays and rollbacks in climate measures and higher costs of climate action, with devastating consequences for human rights.[147] ISDS provisions allow foreign investors to bring

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[141] *Laplane J et al, (2025); BankTrack, (2024); Koagne A, et al, (2021)*

[142] *Laplane J et al, (2025); BankTrack, (2024)*

[143] *ACLED, (2025); Gaventa J, (2021); van Teeffelen J and V Kiezebrink, (2023); Halsey R, et al, (2023)*

[144] *Koagne A, et al, (2021)*

[145] *Laplane J et al, (2025); BankTrack, (2024)*

[146] *Koagne A, et al, (2021)*

[147] *Lee E and J Dilworth, (July 2024); Boyd DR, (2023)*

claims against host countries if they consider their business interests to be undermined by measures introduced by those governments, such as stricter climate change measures.

As a result of ISDS provisions, Mozambique could be exposed to USD 7-31 billion in liabilities in relation to oil and gas projects still awaiting final investment decision, and an additional USD 5-19 billion in relation to projects already in development.[148] Governments are encouraged to withdraw consent to ISDS, commit to remove ISDS clauses from trade agreements and contracts, and take measures to prevent companies from accessing ISDS.

Financial institutions must ensure that the companies and projects they finance, their representatives and their lobbyists, do not exert undue influence on public decision-making processes, especially those aimed at safeguarding peoples from corporate crimes and violations.[149] Policies should include strong anti-corruption policies and prevent the revolving-door phenomenon, or the movement of employees from the private sector to public regulators and other agencies.

In order to adhere to the 1.5 degrees C threshold, present LNG export capacity is already sufficient to meet current and future demand, and no new gas infrastructure should be developed.[150] The investment policies of financial institutions should ensure that any companies they support place a moratorium on new fossil gas exploration and development, and commit to phasing down all fossil fuel operations in line with the 1.5 degrees Celsius threshold.

Greenhouse gas reporting has been integrated into law in several countries.[151] Financial institutions should establish, for their own direct and indirect greenhouse gas emissions, their measurable reduction objectives that are aligned with the 1.5 degrees C limit.[152] Scope 3 for financial institutions includes financed emissions, which is estimated to be over 99% of reported emissions.[153] Companies and projects financed must be bound to disclose their full scope 1, 2 and 3 greenhouse gas emissions for accountability and setting meaningful reduction targets.

Recommendations for financial institutions

- Commit significantly increased support for the transition towards economies and energy systems that are centred on the needs of peoples and the protection of nature.
- Require that companies or projects financed respect the Free, Prior and Informed Consent of local peoples and communities, which must necessarily imply the Right to Say No, or the right to veto any new project if they consider it will not benefit them, or poses risks to their rights.
- Require that companies and projects financed safeguard the rights of Indigenous peoples and environmental and human and rights defenders, including and especially where any concerns are raised in relation to their projects.

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148 *Tienhaara K, et al, (2022)*

149 *Koagne A, et al, (2021)*

150 *Runciman J, (November 2024); IEA, (October 2024); IEA ,(2021), IEA, (2023), IPCC, (2023)*

151 *Aiuto K, et al, (March 2024)*

152 *Laplane J et al, (2025); BankTrack, (2024)*

153 *Hadziosmanovic M, et al, (June 2022); IFC, (2023); CDP, (June)*

- Place a moratorium on new financing for fossil fuel exploitation, across the full value chain, and reject the consideration of fossil gas as a transition fuel.
- Divest or withdraw from existing investments in companies involved in new fossil gas exploration or any fossil gas expansion, across the full value chain.
- Require that companies and projects financed disclose their full projected scope 1, 2, and 3 emissions and set emissions reductions targets that are in line with the 1.5 degrees Celsius limit.
- Commit to support the reform of investment law to prevent any limitations on States to enhance regulatory capacity on environment, climate change and human rights.
- Require that financed companies and projects exclude the use of ISDS provisions.
- Exclude financial support for projects that will result in or have a reasonable risk of causing irreversible harm to local, regional or global ecology and biodiversity, or which will cause harm to species and areas that require special conservation strategies.
- Where projects are under consideration, and before committing financial support, require thorough and scientifically sound environmental and social impact assessments of project activities that include:
  - Thorough, scientifically sound and peer-reviewed baseline studies of the habitats and biodiversity of the terrestrial, near-shore and deep ocean areas affected by gas exploitation, including identification of species that require special conservation attention and areas of high conservation value.
  - Thorough, scientifically sound and peer-reviewed cumulative impact assessments that establish clearly the combined and successive incremental impacts of the gas projects together and over the extent of their projected lifetimes, including the impacts of related marine traffic, and impacts on commercial and subsistence food species.
  - Thorough assessment of any negative impacts to endangered and culturally important plant and animal species, areas of high conservation and traditional value, and areas protected under international conventions and agreements, such as those under United Nations Educational, Scientific and Cultural Organization (UNESCO), the International Union for Conservation of Nature (IUCN), and the Ramsar Convention on Wetlands.
- Exclude financing for companies and projects operating or planned in conflict or militarised zones.
- Exclude financing for companies and projects associated with human rights violations.
- Exclude financing for companies and projects operating in countries with evidence of civic repression or human rights violations, or reports of persecution of local communities who resist large-scale land, water and resource grabs.
- Require that companies and projects financed disclose any information related to financed projects when this information is requested in the interest of protecting human rights or the environment, or in the interest of expanding access to justice of affected peoples.

Recommendations for the financial institutions already committing financial support to the Rovuma Basin gas projects

- Place an immediate moratorium on all gas project activities, in application of the Precautionary Principle, until there is thorough understanding of the ecological value of the Rovuma Basin and Afungi Peninsula as well as a thorough understanding of the full projected impacts of the gas projects on the habitats and biodiversity of the region.
- Require full disclosure of scope 1, 2, and 3 emissions from the projects, and scientifically sound assessment of whether there is alignment with the 1.5 degrees C limit. Should these emissions not be compatible with the commitment, divest or withdraw support from the projects.
- Require the conduct of thorough, scientifically sound baseline studies of the habitats and biodiversity of the terrestrial, near-shore and deep ocean areas affected by the gas projects, including identification of species that require special conservation attention and areas of high conservation value.
- Require the conduct of thorough, scientifically sound and peer-reviewed cumulative impact assessments that establish clearly the combined and successive, incremental impacts of the gas projects together and over the extent of their projected lifetimes, including impacts of related marine traffic, and impacts on commercial and subsistence food species.
- Withdraw support from the gas projects and require that any development is permanently stopped, should there be evidence or a reasonable risk that gas exploitation will result in irreversible harm to local, regional or global peoples or ecological systems, or cause harm to species and areas that require special conservation strategies.
- Require that all project activities are monitored and assessed for environmental and social impacts by an independent team using thorough, scientifically sound methodology.

References

Environmental Impact Assessments of four Rovuma Basin gas projects

All critiques of environmental impact assessments appearing in this report, as well as general information on the gas projects discussed, refer to the following five documents:

- EIA Report for the proposed Liquefied Natural Gas (LNG) Project associated with the gas fields within Area 1 Offshore of the Rovuma Basin (Area 1) and Area 4 Offshore of the Rovuma Basin (Area 4), prepared by Environmental Resources Management (ERM) Southern Africa (Pty) Ltd, in association with Projectos e Estudos de Impacto Ambiental, Lda. (Impacto), on behalf of Anadarko Moçambique Área 1, Lda (AMA1) and Eni East Africa S.p.A. (February 2014)
  - Referred to in this document as ***RM-EIA***
- Environmental Impact Assessment Process for the Floating Liquefied Natural Gas Project – Environmental Impact Study: Final Report, Eni East Africa, S.p.A. (March 2015)
  - Referred to in this document as ***CS-EIA***
- Environmental and Social Supplementary Lender Information package, issued by Rovuma LNG (June 2019)
  - Referred to in this document as ***R-ESS***
- Environmental, Social and Health Impact Assessment (ESHIA) Executive Summary and Update for the Mozambique Liquefied Natural Gas Project, published by Total E&P Mozambique Area 1 (TEPMA 1) (May 2020)
  - Referred to in this document as ***M-ESHIA***
- North Choir EIA (Preliminary Report), Mozambique Rovuma Venture S.p.A. /Consultec (February 2024)
  - Referred to in this document as ***CN-EIA***

Unless otherwise stated, the biodiversity baseline description in this report is based on information presented in the EIAs, specifically in the following documents:

- The baseline description provided in chapters 7 and 8 of the Environmental impact assessment (EIA) prepared by Environmental Resources Management (ERM) Southern Africa (Pty) Ltd, in association with Projectos e Estudos de Impacto Ambiental, Lda. (Impacto), on behalf of Anadarko Moçambique Área 1, Lda (AMA1) and Eni East Africa S.p.A., in 2014;
- Sections 5.2 and 5.3 of the Environmental, Social and Health Impact Assessment (ESHIA) Executive Summary and Update for the Mozambique Liquefied Natural Gas Project published by Total E&P Mozambique Area 1 (TEPMA 1) in May 2020;
- Chapter 4 of the Environmental and Social Supplementary Lender Information package issued by Rovuma LNG in June 2019; and
- Chapter 6 of the North Choir EIA (Preliminary Report) issued by Consultec in February 2024.

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