




Review

A Review of Environmental Protection and Sustainable Development in Madagascar

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Abstract: Environmental protection is an important key to achieving sustainable development. Since humans depend on the environment in countless ways, preserving them contributes directly to the sustaining of people and human societies and hence, to social sustainability. The central question in this dissertation asks why the environmental protection policies enacted in Madagascar are not efficient and how they impact the SDG's achievement at the national level. This paper discusses Madagascar's achievements of the sustainable development target with special emphasis on environmental issues, which is currently a major concern in the country. This review aimed at suggesting improvements in line with the challenges the country is facing by reviewing the indicators provided by the UN SDGs. It also reaffirmed the nexus of poverty and the environment, which is important for setting the development target. In order to conduct this study, journal articles, review papers, working papers, research reports, and books related to environmental management and sustainable development in Madagascar were reviewed. Madagascar has made a little improvement in accomplishing SDGs 12 and 13 in 2021, but achieving all SDGs goals in 2030 remains a big challenge. The country is a party to numerous international environmental conventions, treaties, and agreements. Many policy changes have been implemented to address both conservation and development issues, but these efforts have had little impact. Forest fires and slash-and-burn were on the rise in Madagascar on October 2022, which poses a major concern for the economic and social development of the island. In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. The strategies proposed in this paper might be helpful for the Malagasy government and private sector in decision-making. This paper is also useful for researchers in developing countries. As Madagascar did not reach the Millennium Development Goals 2015 and will not achieve the SDGs in 2030, should we not start learning from our mistakes and thinking about the post-SDGs?

Keywords: environmental protection; sustainable development; strategy; legal framework; Madagascar



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1. Introduction

The world population is expected to reach 9.6 billion people by 2050 [1]. If current consumption and production patterns remain unchanged, we will need two planets to sustain our lifestyles in 2050. Demographic and industrial development is also leading to a warming of the planet's atmosphere, which unbalances and endangers its inhabitants. Since humans depend on the environment in countless ways, preserving them contributes directly to the sustaining of people and human societies and hence, to social sustainability. Protecting the environment and its resources has therefore become a priority issue.

Located on the East coast of Africa, Madagascar is the world's fourth-biggest island; Madagascar is host to 12,000 species of vascular plants (96% endemic). Over 90% of all its wildlife is found nowhere else on earth, and 5% of all of the earth's biodiversity is found in Madagascar [2]. A place where environmental degradation problems have created

severe erosion and water quality problems. Despite its biological and cultural diversity, Madagascar is among the poorest countries in the world, with approximately 78% of the population living in extreme poverty with an average income of less than USD 2 per day [1], and more than three-quarters of the population in rural areas engaged in natural resources dependent livelihood activities [3]. As such, people's day-to-day survival is dependent upon natural resource use. They must live off the land that surrounds them, making use of whatever resources they can find. Their poverty costs the country and the world through the loss of the island's endemic biodiversity [4]. Additionally, the island's biodiversity is at risk due to traditional agricultural practices, overexploitation through hunting and logging of certain species, and uneven protection afforded to natural areas by the Malagasy government [5].

Regarding unsustainable resource use, deforestation, and habitat degradation facilitate erosion, changes in local climates, air pollution, water pollution, and the loss of livelihoods [6–8], the cycle of poverty must be broken if the environmental protection program is to be viable in the long term [3]. These issues draw our attention to the environment and recognize the importance of environmental protection in development. This paper discusses Madagascar's achievements of the sustainable development target with special emphasis on environmental issues, which is currently a major concern in the country. This review aims at suggesting improvements in line with the challenges the country is facing by reviewing the indicators provided by the UN SDGs. It also reaffirmed the nexus of poverty and the environment, which is important for setting the development target. In order to conduct this study, journal articles, review papers, working papers, research reports, and books related to environmental management and sustainable development in Madagascar were reviewed.

2. Theoretical Background

2.1. Environment Concept

An environment is a set of natural, artificial, man-made, physical, chemical, and biological elements that make the existence, transformation, and development of living organisms possible. The International Union for Conservation of Nature (IUCN) [9], in article 1, defines the environment as "all of nature and natural resources, including cultural heritage, and human infrastructure essential for socio-economic activities".

By referring to some international declarations, the close relationship between the environment and man can be defined as follows:

- The Stockholm Declaration of 1972, containing 26 principles, was to create a better international jurisprudence for environmental law. The protection and improvement of the environment is a problem of major importance that affects the wellbeing of people and economic development [10]. It was mentioned that pollution must not exceed the environment's capacity to clean itself. Developing countries need assistance and reasonable prices for exports to carry out environmental management. Rational planning should resolve conflicts between the environment and development. The policy must not hamper development. It stated that a lack of progress is unacceptable (Chapter 7, paragraphs 37 and 44). This priority given to economic growth while talking about renewable resources and future generations seemed paradoxical and was set in stone early on. One of the major results of the Stockholm conference was the creation of the United Nations Environment Programme (UNEP);
- The World Charter for Nature, drawn up by IUCN and solemnly containing 24 principles, proclaimed by the United Nations General Assembly on 28 October 1982, affirms that "humanity is part of nature and that life depends on the uninterrupted functioning of natural systems which are the source of energy and nutrients" [11]. The need for measures to protect nature at all levels (national, international, individual, collective or public, and private) was identified. For that, it is vital to acquire the knowledge to maintain and enhance the ability to use natural resources in order to ensure the preservation of species and ecosystems for the benefit of present and future generations. The

Charter does not solve any of the difficult problems of funding, staffing, and technical assistance necessary to coordinate economic development with conservation;

- The Declaration on Environment and Development, containing 27 principles, was adopted in Rio de Janeiro on 14 June 1992, whose preamble makes the earth “the home of humanity, thus constituting a whole marked by interdependence” and whose principle 4 emphasizes that “to achieve sustainable development, environmental protection must be an integral part of the development process and cannot be seen in isolation” [12]. It mentioned that human beings are entitled to live healthy and productive lives in harmony with nature (Principle 1). Other most important principles in this Declaration are intergenerational equity (Principle 3), precautionary principle (Principle 15), and the polluter pays principle (Principle 16). It stated that long-term economic progress is only ensured if it is linked to the protection of the environment. Therefore, nations must establish a new global partnership involving governments, their people, and the key sectors of society.

The environment performs vital functions: such supplies resources. Resources here include both renewable and non-renewable resources; it assimilates waste, sustains life by providing genetic and biodiversity, and it also provides aesthetic services such as scenery.

2.2. Sustainable Development

2.2.1. Origin and Concept of the SDGs

The concept of sustainable development has made society conscientious and, at the same time, recognizes the role and importance of environmental factors as well as the functions and services the environment provides. It was first discussed in the mid-1970s and then defined by the United Nations as development that meets the needs of the present without compromising the ability of future generations to meet their own needs [13]. The concept of sustainable development is based on three pillars, such as ecology, economy, and society. It emphasized that the term “need” must be applied particularly to the needs of the poor. Sustainable development requires meeting the needs of all because a world with widespread poverty will be prone to ecological and other catastrophes [12]. Sustainable development goes through social development, meeting the needs of each citizen, the rational and sustainable use of natural resources, the maintenance and safeguarding of ecosystems, and the processes that govern life. This emphasizes the need for cooperation between people and solidarity between present and future generations to achieve sustainable development. With this, it is our responsibility to preserve the environment for future generations in such a way as to ensure them a decent standard of living, and each act, activity, and action that is undertaken is carried out in such a way as to produce no negative consequences for the environment. However, putting it into practice demands tremendous effort. Its application forces governments and societies, and the different sectors that make up those societies, to work together in an attempt to correct errors, change activities, and adjust courses of action. Since the Rio Summit in 1992 and the Johannesburg Summit in 2002, the international community has gradually become aware of the challenges of sustainable development and of the need to transform cultural references, lifestyles, traditions, research, and develop strategies to address them. All countries were invited to develop sustainable development strategies to implement coherent global policies.

At present, sustainability has forced many nations worldwide to address it in their policies and strategies, as it was accepted and ratified as an international agreement during the World Summit on Sustainable Development held in Johannesburg in September 2002. Environmental protection is becoming an international priority that requires a vast redistribution of financial, scientific, and technical resources on a planetary scale and also the implementation of several strategic imperatives for sustainable development.

2.2.2. Madagascar’s Progress in Achieving the SDGs

Based on the Sustainable Development Goals Report 2022, Madagascar has significant challenges in achieving the SDGs. The country has reached 50.12% (overall score) of all

17 SDGs. Regarding the SDG Index rank, the performances of Madagascar ranks 156th out of 163 countries (see Figure 1).

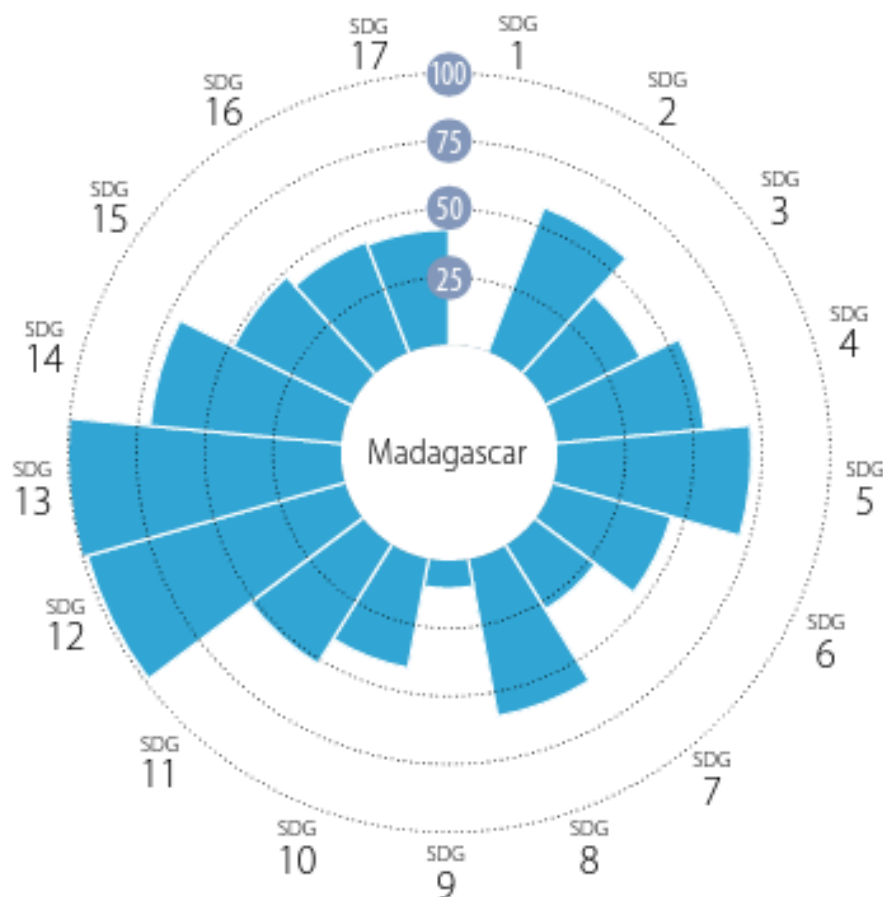


Figure 1. Madagascar's average performance by SDGs (Data Source: Sustainable Development Report).

Despite being one of the nations most affected by climate change [14,15], the graph demonstrates that Madagascar has achieved a little improvement in accomplishing SDGs 12 (Responsible Consumption and Production) and 13 (Climate Action) [16]. The performance by indicators shows that nitrogen emissions and CO₂ emissions from fossil fuel burning and cement manufacture are falling per capita. Climate change must be addressed since it will have a detrimental influence on Madagascar's forests in the future [17]. The majority of Malagasy people rely on natural environment products in their daily life. In order to meet their basic needs, people exploit wetlands, forests, grassland, rocks, the atmosphere, water, and other natural resources. Therefore, they cause significant disruption to the environment's natural equilibrium. Some research advocated for immediate conservation action and protective laws to conserve Madagascar's fauna and flora.

If we now turn to SDGs 5 (Gender Equality) and 8 (Decent Work and Economic Growth) achievements, the graph indicates that there was a moderate improvement from 2017 to 2022. The proportion of females aged 15 to 49 who use modern family planning methods has increased. Previous research has shown that Madagascar's Ministry of Health and Family Planning (MOHFP) has extended the use of community-based distribution (CBD) services for injectable contraceptives [18] and family planning using modern methods (DFPSm) [19]. One of the major causes of Madagascar's population increase is a lack of education, particularly among sexually active adolescent girls and young women (AGYW). Based on the report, the population finishing lower secondary school (35.5%) in 2019 and the rate of literate persons aged 15 to 24 (79.9%) in 2018 both decreased. Environmental sustainability cannot be accomplished in an uneducated community, according to reports [20]. Moreover, many teachers are underqualified and have knowledge gaps in Education for

Sustainable Development (ESD) [21]. The integration of indigenous knowledge is a core in the educational system of indigenous communities to achieve ESD. People are unable to become active in environmental protection due to a lack of understanding [22]. Despite being proven as a vital tool for biodiversity conservation, environmental education (EE) is not yet included in the Malagasy school curriculum [23]. Furthermore, the performance indicators revealed a rise in the percentage of people over the age of 15 who have a bank or other financial institution account or a mobile-money-service provider account.

This outcome contrasts with the attainment of SDG 1 (No Poverty) since the majority of the population lives on less than USD 1.90 per day. The country's annual GDP growth is estimated to decrease by 2.6% in 2022 compared to 4.4% in 2021 [24]. According to previous research, Madagascar performed very poorly on both SDGs 1 and 2, as well as the overall agriculture-related SDG composite index [25]. The world's fourth-highest rate of chronic malnutrition, 33% of the population, is food insecure [26]. It was reported that weather extremes were the main drivers of acute food insecurity in eight African countries, with 23.5 million people in crisis or worse (IPC/CH Phase 3 or above) or equivalent, including in southern Madagascar, where nearly 14 000 people were in Catastrophe (IPC Phase 5) in April–September 2021 due to the effects of drought. Madagascar's Grand Sud experienced the worst drought conditions of the last 40 years, with crop production 50–80 percent below the five-year average [27].

Regarding SDG 6 (Clean Water and Sanitation), it was considered a major element of the 2030 Sustainable Development Agenda. However, only 54% of the population uses safely managed and basic water services, 42% practice open defecation, and 27% have access to water and soap handwashing facilities (see Figure 2) [28].

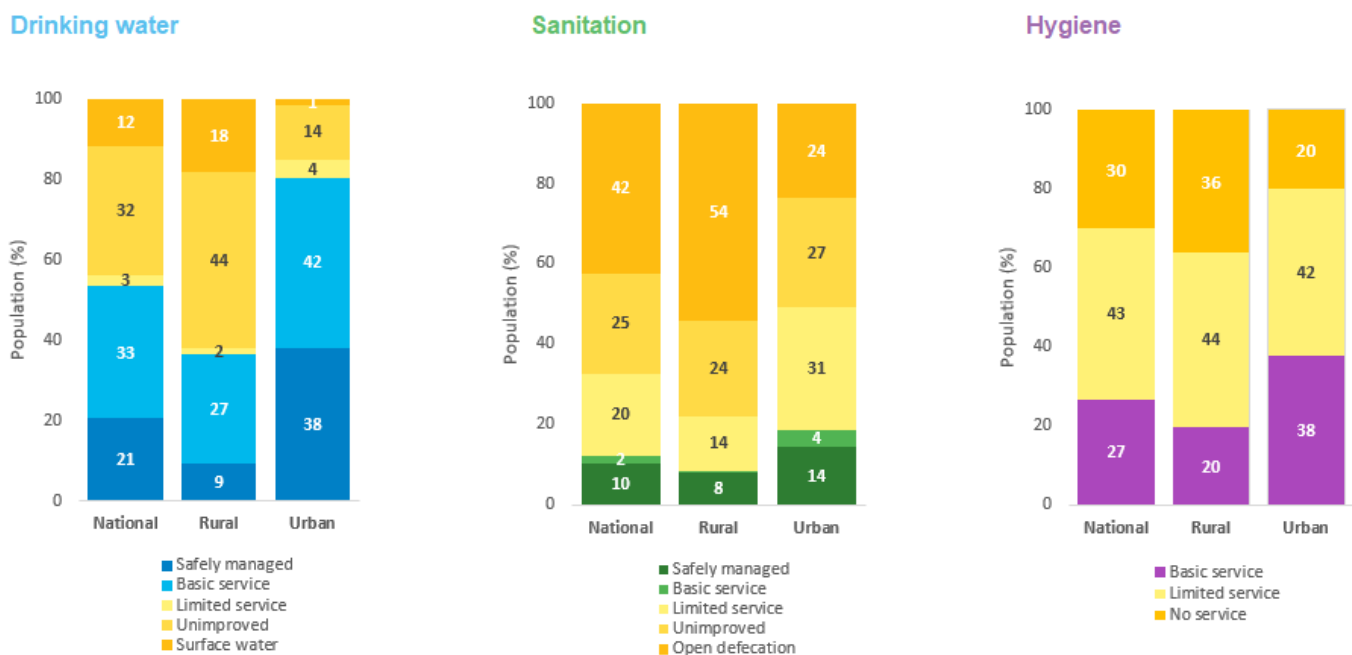


Figure 2. Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (Data source: WHO/UNICEF JMP 2021, <https://washdata.org/> (accessed on 26 September 2022)).

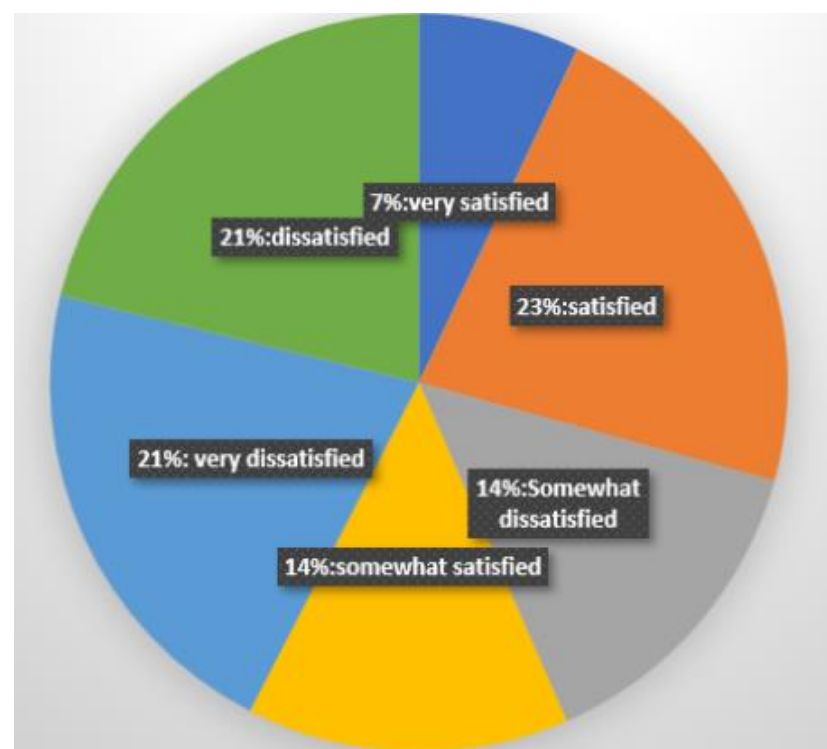
A previous study stated that the country's performance was rated as the worst in terms of the water stress indicator for SDG 6 [28,29]. Table 1 presents the benchmarking of water utilities in Madagascar by the National water and electricity known as the Jiro sy Rano Malagasy (JIRAMA), a state-owned enterprise from 2017 to 2020.

Table 1. Benchmarking of water utilities in Madagascar from 2017 to 2020.

Jiro sy Rano Malagasy	2017	2018	2019	2020
1.1—Water Coverage (%)	55.96%	54.78%	54.37%	53.84%
11.1—Unit Operational Cost Water and Wastewater (USD/m ³ sold)	0.43	0.47	0.54	0.48
12.3—Staff Water/000 Water pop served (#/000 W pop served)	0.28	0.28	0.27	0.26
18.1—Average Revenue W&WW (USD/m ³ water sold)	0.32	0.3	0.28	0.26
23.1—Collection Period (days)	473.13	430.38	544.65	691.34
23.2—Collection ratio (%)	98.59%	89.49%		93.81%
24.1—Operating Cost Coverage (ratio)	0.75	0.64	0.52	0.55
4.1—Total Water Consumption (liters/person/day)	57.82	59.74	60.68	57.79
4.7—Residential Consumption (liters/person/day)	46.25	48.47	49.5	47.76
6.1—Non-Revenue Water (%)	40.56%	41.63%	40.42%	43.92%
6.2—Non-Revenue Water (m ³ /km/day)	46.14	49.61	47.26	51.98
8.1—Water sold that is metered % (%)	0.00%	0.00%	0.00%	0.00%

Source: International Benchmarking Network for Water and Sanitation Utilities (IBNET) (<https://www.ib-net.org/> (accessed on 26 September 2022)).

Table 1 highlights that JIRAMA does not respond to the needs of the population. From 2017 to 2020, water coverage and water consumption decreased throughout the whole country. According to local newspapers, La Verité, Midi Madagascar, L'Express de Madagascar, and Madagascar Tribune, water outages frequently occur due to technical and logistical issues, water shortages, and climate change. People wait in long lines to obtain water, which leads to a loss of time. Almost two out of three do not have running water. In addition, the price of 20 L of jerrycan water rises from 200 Ariary to 2500 Ariary at peak times, according to WSUP Madagascar. Fifty percent of JIRAMA subscribers to piped water consider its cost to be very expensive. Figure 3 presents the results of a survey conducted by the Stileex team about people's opinions on JIRAMA. A total of 1045 people gave their opinion on JIRAMA.

**Figure 3.** Water user satisfaction on JIRAMA services (Data source: STILEEX).

The water shortage and power outage issues in Madagascar have significant economic and social impacts across the country. The JIRAMA should provide safe and affordable

drinking water to the Malagasy people. Researchers proposed that the co-benefits of sustainably managing nature contribute to clean water and sanitation (SDG 6); forest cover protection (SDG 15.2); carbon storage (SDG 13) as part of the Paris Climate Agreement; and nationally defined contributions, biodiversity (SDG 15.5), and also to trade-offs with the zero-hunger objective (SDG 2).

Overall, Madagascar has a long way to go in SDGs achievement, particularly SDG 1 (No Poverty), 6 (Clean water and sanitation), and 9 (Industry, Innovation, and Infrastructure). All resources should be mobilized to attain universal WASH services by 2030. Actions must be performed, therefore, to integrate disaster risk measures, sustainable natural resource management, and human security into national development strategies. The next section of this paper was concerned with the legal framework used and environmental degradation in Madagascar.

3. Legal Framework of the Environmental Considerations in Madagascar

In 1990, the Environmental Charter was formulated. Considering the situation in the current world, the Charter was revised as “Charte de l’Environnement Malagasy” (Law No. 2015-003) in 2015 [30]. The Charter is the basic law on environmental considerations in Madagascar. Article 20 states that both Strategic Environment Assessment (SEA) and Environmental Impact Assessment (EIA) are key actions to guarantee the implementation of good environmental governance by all stakeholders. The Charter requires an EIA for all investment projects, which have been implemented through successive decrees and regulations on the compatibility of investments with the environment known as *Mise En Compatibilité des Investissements Avec l’Environnement* “MECIE” (the current version being Decree 2004-167) [31]. Under the Decree, proponents of a project must show how it will meet environmental standards.

The MECIE decree was enacted by Decree No. 99-954 of December 15, 1999, amended by Decree no. 2004-167 of 3 February 2004, relating to the implementation compatibility of investments with the environment (MECIE). It was considered a success beyond just implementing the EIA because it recorded all rules related to the exploitation of the ecosystem in Madagascar and was founded on the notion of sustainable development, recognizing the needs of the present while safeguarding the needs of future generations [32]. Both private and public sectors have to use the MECIE in cooperation with institutions that are settled especially for the management of the ecosystem, such as the National Office of the Environment (ONE) and the National Authority for Water and Sanitation (ANDEA). In order to improve its application, some measures were designed to increase the speed of the EIA process and reduce costs while ensuring minimum acceptable quality standards, and establishment of a one-stop-shop in the National Environmental Office (ONE) for evaluation of EIAs and issuance of environmental permits [33]. Section 1, methods of assessment of impacts: the EIA, pursuant to Articles 3 and 7, is carried out at the cost and under the responsibility of the proponent, and its contents depend on the importance of works and installations to be undertaken and on their potential impacts on the environment. Investors were required to pay between 0.1% and 0.5% (according to the size of the projects) of the total value of the investment to the ONE. The law requires impact assessments for listed types of projects and for any other activities that could hurt the environment. Assessments are required to include environmental management plans. The process provides for public participation thorough review of the relevant documents, a public inquiry, or a public hearing. The assessment provides a basis for the decision of whether to issue an environmental permit allowing the action to go forward.

Table 2 presents other related laws to the environmental considerations in Madagascar. These legal frameworks were chosen because they govern the areas of pollution, waste, and environmental complaints in Madagascar.

Table 2. Related laws to the environmental considerations in Madagascar.

No.	Law (Order, Decree, Act) Number	Brief Description
1	Law No. 98-029 of 20/01/1999	Water utilization and effluent regulation
2	Law No. 99-021 of 19/08/1999	Pollution control and policy
3	Order No. 18177/04 of 27/09/2004	Sensitive areas in the forest
4	Order No. 4355/97 of 13/05/1997	Environmental sensitive areas
5	Ordinance No. 93-022 of 04/05/1993	Regulations on fishery and fish culture
6	Law No. 95-017 of 25/08/1995	Regulations on tourism
7	Decree No. 96-1293 of 30/12/1996	Establishment and management of tourism areas
8	Law No. 98-026 of 20/01/1999	Road
9	Law No. 00-022 of 19/08/1999	Mining
10	Decree No. 2000-170 of 18/11/2000	Mining
11	Inter-ministerial Order No. 12032/2000 of 06/11/2000	Mining
12	Decree No. 2012-430	Environmental and social protection for mining
13	Act No. 2003-010	Bureau National de Gestion des Risques et des Catastrophes: BNGRC
14	Act No. 2011-002	Sanitation code
15	Act No. 98-029	Water code
16	Act No. 2003-044 of 28/07/2004	Labor code
17	Decree No. 2003/464 of 15/04/03	Effluent standard
18	Law No. 96-025 of 30/09/1996	Natural resources
19	Law No. 2005-018 of 17/10/ 2005 on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Law regarding CITES
20	Ordinance No. 60-127 of 3/10/1960 Ordinances No. 62-127 of 1/10/1962 and No. 75-128 of 22/10/ 1975	Prevention of wildfire
21	Law No. 2001-005 11/02/ 2003	Protected areas
22	Ordinance: No. 82-029 of 06/11/1982	Protection of national monuments
23	Law No. 2005-006 of 14/07/2005	Policy on culture
24	Law No. 2015-003 of 20 January 2015	Environmental Charter (update)
25	Decree No. 99-954 of 15 December 1999, amended by Decree No. 2004-167 of 3 February 2004	Compatibility of investments with the environment

Sources: From 1 to 12: Walmsley, B. et al., 2007 [16]; From 13 to 16: FID, 2015 [17], From 17 to 23: Feno, Paul-Jean, 2017 [18], and from 24 to 25 [30].

Madagascar is a party to numerous international environmental conventions, treaties, and agreements. However, the integration of the obligations conferred upon Madagascar by these treaties' legislative framework has not been fully achieved [3]. Table 3 illustrates the international environmental agreements which Madagascar integrated.

Table 3. Madagascar's International Environmental agreements.

International Environmental Agreements	Year Entered into Force
Convention on Fishing and Conservation of Living Resources of the High Seas Vienna	1966
Conservation of Wetlands of International Importance (Ramsar Convention)	1975
Conservation on the International Trade in Endangered Species of Wild Flora and Fauna (CITES)	1975
Convention for the Protection of the Ozone Layer	1988
Montreal Protocol on Substances that Deplete the Ozone Layer	1989
Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal (Decree No. 99-141 of 22 February 1999)	1992
Convention on Biological Diversity	1993
United Nations Convention on the Law of the Sea	1994
United Nations Framework Convention on Climate Change (UNFCCC)	1994
United Nations Convention to Combat Desertification	1996
Kyoto Protocol to the UNFCCC	2005

Source: CIA World Factbook, 2012 [19].

Environmental Action Plan

In Madagascar, the adoption of the Malagasy Environment Charter on 21 December 1990 (Law 90-033) enabled the establishment of the Malagasy National Environmental Action Plan (NEAP) [34]. The adoption of the NEAP is based on the efforts to achieve the goals set by the Stockholm conference in 1972 [10]. Madagascar's NEAP, one of the first in Africa [35], was the principal environmental program in Madagascar that advocates the development of rural and urban areas considering the environmental factor and their protection as a means of ensuring sustainable development [36]. The main purpose of the NEAP is to protect the environment while focusing on sustainable development. The NEAP is made up of three environmental programs whose succession reveals the relationship between environmental policy and rural development policy:

- The first environmental program (1991–1996) was characterized by a centralized approach to the management of the environment and natural resources: zoning of protected areas based on scientific criteria without consultation with local actors and stigmatization of agriculture as the main source of resource degradation;
- The second environmental program (1997–2002) aims to optimize the management of natural resources for human development needs. The general framework for the implementation of environmental policy in its second phase is mainly focused on the intensification of more concrete actions on the ground;
- The third environmental program (2003–2008) focuses on conserving and enhancing the size and quality of natural resources to enable sustainable economic growth and a better quality of life. The objectives of the program are the adoption by the populations of sustainable management methods for renewable natural resources and biodiversity conservation, ensuring the sustainability of the management of environmental natural resources at the national level.

The MECIE decree requiring environmental impact assessment in Madagascar is considered by some to be one of the big successes of the NEAP. However, after 25 years, the environmental crisis in Madagascar is far more acute than it was at the outset of the first phase of NEAP [37].

4. Poverty and Environmental Degradation

According to the 2022 Environmental Performance Index (EPI), Madagascar is among the countries with the worst environmental health. Madagascar ranks 167 out of 180 countries and 44 in Sub-Saharan Africa, with a score of 28.0 [38]. Poverty and the environment are inextricably linked. Poverty causes environmental degradation, and environmental degradation exacerbates poverty rates. Other authors also questioned the vicious circle between poverty and environmental degradation. They found that poverty is both cause and effect of environmental degradation. Population growth, the shift from rural to urban investment, the growth of urban centers, and internal resource exploitation all lead to repeated cycles of increased poverty and environmental degradation [39]. According to the Bruntland Commission report, poverty is a major cause of environmental problems [13]. In addition, some studies have confirmed that economic development depends on the environment [40–44]. Human activities are the main reasons for environmental degradation, and the poor are often referred to as the primary actors in it [45,46]. Poor people are often impoverished by a declining resource base and, in turn, often forced by their circumstances to degrade the environment further [13,47–49].

Whether it is in the form of air and water pollution, deforestation, soil erosion, or the extraction of natural resources itself, the fact is that developing countries are currently accounting for the remarkable depletion of natural resources [50]. Poor people are forced to use excessive environmental resources to survive. Indeed, the degradation of their environment makes their survival even more difficult and further impoverishes them [13]. It has been proved by recent famines in Sub-Saharan Africa. Furthermore, the poor are often characterized by their vulnerability to not only economic fluctuations but also to environmental degradation and change. They suffer the first consequences of environmental degradation. They do not have the slightest safety net, which is generally the case in developing countries and especially because they generally derive their subsistence from natural resources. Moreover, environmental degradation accentuates inequalities between the rich and the poor.

Nevertheless, there is a growing view that the poor are not necessarily the main agents responsible for resource degradation: quite often, the rich play a much greater part in this process [51,52]. Since the poor do not have the resources, or the means, to cause environmental degradation [53]. It is often not the poorest who hunt wildlife [54,55]; the powerful and wealthy only degrade the environment if there are institutional or market failures or engage in the illegal exploitation of precious wood [56,57]. Figure 4 illustrates some examples of the major causes and effects of environmental degradation in Madagascar.



Figure 4. Example of major causes and effects of environmental degradation in Madagascar (Source: Authors).

Previous studies found that the high population density and rising demand for natural resources were the main cause of environmental degradation in the South (developing countries) [29]. By 2050, the population growth in Africa will be 108% of the present value [58], the industrial water demand will be 800% of the present value, and the home water demand will be 300% [59] of the present value. From 1993 to 2018, the Malagasy population was predicted to be 25,674,196 people, with an average population density of 43.3 people per km² and an annual growth rate of 3.01% [60]. The majority of the population (80.7%) resides in rural areas, while 52% live in the Central Highlands and coastal zones. Figure 5 below illustrates the future population in Madagascar.

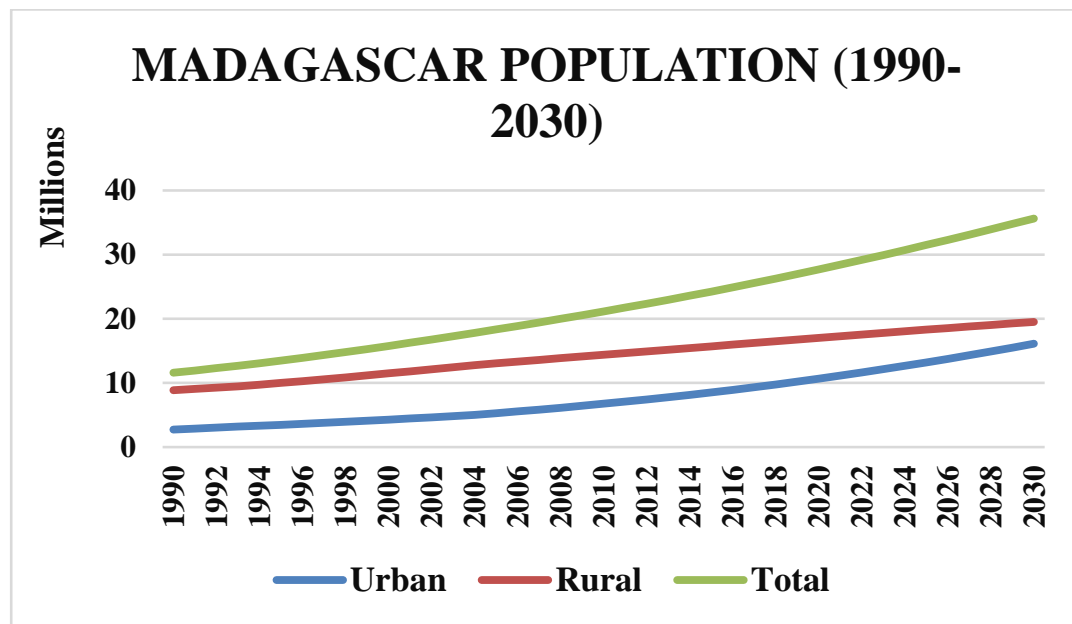


Figure 5. Madagascar population from 1990 to 2030. Data source: UN DESA Population Division World Population Prospects (2019) and World Urbanization Prospects (2018).

Water scarcity and pollution are two main concerns that contribute to the poverty-environmental degradation nexus. Water scarcity is mostly driven by climate change, excessive groundwater pumping, irrigation system development, and industrial water demand [61]. Human waste is one of the leading causes of water pollution in Madagascar, followed by industrial waste dumping and fertilizer or pesticide runoff from the agricultural sector. One of the major impacts of environmental degradation is associated with health effects, food sources, and drought [62].

In Madagascar, environmental preservation is hostage to economic development. Economic development is hostage to bad governance [16]. There are several reasons for directing the policies in the wrong way. Madagascar ranks 155th of 180 countries listed in the Corruption Perceptions Index in 2018 and 142nd in 2021 [63]. As the potential to reap personal benefits from the environmental sector are considerable (logging permits, significant donor funds), the environment ministry is among the most coveted, and many of its ministers are known to have benefited from illegal activities. Corruption undermines environmental programs at all levels, and its insidious impacts reverberate throughout the system. Logging, mining, and even slash-and-burn agriculture permits are freely distributed in ecologically sensitive zones [16]. A previous study confirmed that the deforestation problem in Western Madagascar is more a governance problem in a context of an unregulated economy than an economic development problem [64]. If the environment is hazardous, it will have a negative impact on the residents. Additionally, environmental protection is a fight against poverty. Madagascar's journey out of poverty is a long one, but good environmental management practices can benefit everyone and help

make poverty reduction efforts more sustainable. The relationship between poverty and environmental degradation must be analyzed to generate significant results for formulating policies to alleviate the condition of poverty and preserve the environment; it is interesting that the condition of poverty is defined comprehensively as a phenomenon of multiple dimensions [65]. In order to achieve this goal, first, it is necessary to provide everyone the opportunity to have sustainable livelihoods and then apply policies and strategies that promote appropriate levels of funding and emphasize policies of integrated human development. For all deprived regions, strategies and integrated programs for the rational and sustainable management of the environment should be developed and emphasized in national development plans and budgets.

The increasing demand for land and natural resources in Madagascar is due to rapid population growth, while environmental degradation is mainly caused by deforestation, slash-and-burn agriculture, and unsustainable exploitation of wildlife, which depletes biodiversity resources and makes many areas less productive for other uses. Lately, forest fires and slash-and-burn (See Figure 6 as an example) are on the rise in Madagascar, which poses a major concern for the economic and social development of the country. Slash-and-burn, known as “Tavy”, is a method of cultivation in which forests are burned and cleared for planting [66]. However, forest clearance is illegal in Madagascar (Décret n° 87–143, 20 April 1987). The land is only fertile for a couple of years before the nutrients are used up. After the planted area’s fertility declines below the necessary level, it is left to fallow for an extended period before the process is repeated [67]. Slash-and-burn agriculture was reported as the main cause of deforestation in Madagascar [68]. Slash-and-burn was demonstrated to have an impact on the quality of runoff waters in a Mediterranean environment (Croatia). The water quality parameters were more affected shortly after burning, while runoff and erosion were more dependent on precipitation patterns [69]. Slash-and-burn was found to lower gross soil nitrogen (N) transformation rates and slower turnover of the soil inorganic N pool in the karst regions of southwestern China [70].



Figure 6. Slash-and-burn agriculture in Bongolava Region, Madagascar. (Photo credit: Zy Misa Harivelo, 20 September 2022).

Researchers stated that the rate of forest destruction in the western, central-eastern part of the island is accelerating [71]. According to the Ministry of the Environment and Sustainable Development, 1054 fire spots were found throughout Madagascar on 9 October 2022. The island’s biodiversity was threatened because protected areas and natural national parks were also affected [72]. A previous study reported an increased burning inside protected areas of 76–248% during the COVID-19 lockdown in 2020 [73]. Six natural parks, namely Ankaraba forest near Tampoketsa, Baie de Bali Soalala, Ankarafantsika, plantations in Marohogo, and Zombitse Vohimbasia, were reported burning by local newspaper *Dépêche TARATRA*, Madagascar-Tribune, Madagascar Matin, and Tsidika on October 2022. In addition, other places were also seen on fire on October 2022, such as in Andranobongobe

Tsarazaza Village Mandimby Laimbolo Commune Sahanivotry Mandonda, Reforestation Site Antanamifafy Ankorefo Boeny Region, Betavolo Fokontany Mandraka, Rural Commune of Ambatolaona, Manjakandriana district (RN2), Rural Commune of Maroambaka Mandritsara, Ambohitantely Ankazobe, North area of Manakara Airport, Antsatramidola and Ambilombe District of Mandritsara, Menagisy Brickaville, Fokontany Bealanana III Sofia region and closed to Ivato airport (Source: BNGRC and Ministry of the Environment and Sustainable Development). Questions have been raised about the main cause of wild-fires and forest fires in Madagascar on October 2022. Is it related to political or social issues that the country has faced during this COVID-19 pandemic? Or is it intentional? A result of poverty? Lack of education? Civil society organizations, tourism actors, and Facebook users are calling on all officials in each category to find a solution to this problem.

It was reported that the poor rural people are the ones who are intensely distorting the island's landscapes to meet their basic daily needs, leading to the highest overall impact on the country's ecosystems and biodiversity. Environmental education in Madagascar is entirely dependent on the efforts of each citizen and the government first, then the international and national non-governmental organizations (NGOs) [23].

Table 4 describes the relationship between poverty and environmental degradation in Madagascar.

Table 4. Relationship between poverty and environment in Madagascar.

Environmental Challenges	Implications for Poor Households	Importance of Poverty Reduction Efforts
Terrestrial and coastal marine degradation	The links between poverty and terrestrial ecosystem degradation in Madagascar are complex and not fully understood; it is thought that, on the one hand, poverty is a driver of degradation and that, on the other hand, the effects of this degradation are most strongly felt by poor households. Data indicate that areas with high forest cover have low population densities but high poverty rates. Data also indicate that deforestation is negatively correlated with wealth and areas of greater inequality in income distribution. Non-costed ecosystem services provided by forests, including water supply, timber, and non-timber forest products, are arguably more important to poor households. Coastal and marine resources are often a fallback in times of failure of agriculture production for households that have no alternative sources of income, either through supplementation of diets with fish products or permanent migration to coastal areas and change in livelihood strategies. In the same manner, protected areas are likely to impose higher opportunity costs on poor households as they are less able to support the restriction of access to natural resources.	High
Urban pollution	The predominant effects of urban air and water pollution are on public health. Poor households are more susceptible to the effects of urban pollution due to their limited access to preventive or curative health services, their often-limited knowledge on matters of sanitation and disease control, their concentration in zones where pollution rates are higher, and clean water and sanitation delivery rates are lower, and their limited economic ability to choose alternative “clean” products or services (e.g., to replace polluting indoor fuels with clean alternatives).	High
Industrial pollution	To date, in Madagascar, industrial pollution is less widespread than other types of environmental problems and results from small-scale unregulated industries in the main urban centers and a small number of mining mega-projects. As for urban pollution, the vulnerability of poor households to the health effects of industrial pollution is likely to be higher than for other income groups, and equally, their ability to lodge complaints or protest against industrial pollution events is more limited.	Medium
Natural disasters and climate change	The degree of vulnerability of a household to natural disasters or climate change is a function of exposure, sensitivity, and resilience. Poverty is thus a key factor in determining the level of vulnerability as it affects all components of vulnerability. Exposure of poor households is often the highest as they are located in the most geographically exposed locations. Sensitivity is also typically higher due to the type of housing or the health of household members, as is the resilience or ability of that household to recover from a shock due to the availability of food reserves, access to credit, access to health services, etc. The effects of natural disasters and climate change are thus more felt by poor households.	High

Source: World Bank, 2013 [3].

5. The Strategy of Environmental Protection for Sustainable Development

Madagascar's major environmental problems include deforestation, water, and air pollution, climate change, agricultural fires, erosion and soil degradation, and overexploitation of living resources, including hunting and over-collection of species from the wild [74]. Sustainable development seemed to be impossible to achieve unless good environmental protections were in place. Therefore, preliminary strategies and measures are proposed, as shown in Table 5.

Table 5. Madagascar environment's priority challenges and proposed solutions.

Priority Challenges	Proposed Solutions
Pollution management	Increased sharing of responsibilities for environmental management and effective institutional organization
Deforestation eradication	Improved application of legal framework establishment of incentive schemes for environmental protection initiatives
Soil erosion management	Development of sustainable financing mechanisms
Natural resource management and biodiversity protection	Improved information, education, and communication at the national level
Fire management	Strengthened actions for prevention and surveillance
Implementation of international conventions Climate change responses	Increased efforts in control and inspection
Environment awareness and mainstreaming public–public and public–private partnership development	Improved mechanisms for control and inspection of environmental impacts of developments
Strengthened responsibility for environmental management at national and sub-national levels	Increased sharing of responsibilities for environmental management and effective institutional organization

Source: World Bank, 2010 [27].

5.1. Air Pollution Reduction Strategy

Ambient air pollution related to transport is mainly a problem in urban areas. Moving to cleaner fuels would bring significant improvements in air quality (AQ). The strategy is to identify all known point sources of air pollution (factories, power plants, brickmakers, etc.) as the basis for AQ projections and implement an early warning system on air quality based on AQ monitoring.

5.2. Water Pollution Strategy

The water pollution strategy needs to focus on the following:

- Development of integrated water resources management to promote cleaner, more resource-friendly, and sustainable methods of extraction and recycling of water and by establishing economic measures that support the rational use of water resources;
- Development of public–private partnerships for drinking water supply or improvement of the irrigation system.

5.3. Reducing and Managing Climate Change Risks

The climate change strategies include:

- Strengthening the technical capacities of stakeholders and affected entities about the climate-smart approaches to generate benefits both for mitigation and adaptation while improving livelihoods and maintaining ecosystem services;
- Monitoring and evaluation of the costs and effectiveness of the various climate-smart landscape measures to achieve adaptation, mitigation, and improved livelihoods for the scaling-up and replication of these measures in other regions;

- Ensuring that financial resources are sustained beyond the closure of the project to support climate efforts in high-value landscapes in Madagascar through capital investments in a trust fund dedicated to climate change;
- Integrating strategies and actions of national policies on climate change in the decentralized planning efforts at regional and local levels.

5.4. Green Economy

A green economy represents an opportunity for low-income countries such as Madagascar, where environmental goods and services are a major component of the livelihoods of poor rural communities and where the environment and its services protect them in the event of natural disasters and economic shocks. Judicious management of natural resources and ecosystems generates positive results in poverty reduction, such as the exploitation of non-timber products leading to job creation and increased income for the benefit of many people, especially in rural areas. In order to create favorable conditions for the development of the green economy, some actions are necessary, such as changes in fiscal policy, reforms, and reduction in environmental damage; targeting public investments in key ecological sectors; taking the environment into account in public procurement; improving environmental regulations and legislation by strengthening their application; training for stakeholders; and a close communication [75]. Citizens also must play a role in determining the success or failure of a global green economy. They must ensure that policies meet their intended aims of economic and environmental sustainability, as well as social equity, which requires broad support from empowered civil society actors and a well-informed and engaged public that includes voters, consumers, and shareholders.

5.5. Renewable Energy Sources

These strategies should aim to promote the use of solar power, hydraulic power, and biofuel. In the rural areas of Madagascar, this approach will contribute to the reduction in GHG emissions from deforestation and forest degradation (use of wood for fuel, cooking, and lighting). Furthermore, the use of renewable energy will have positive impacts on health as households will not be exposed to smoke from wood and charcoal fires. Better access to electricity in rural areas promotes small agricultural transformation units, resulting in more employment and improved local health services or agricultural services.

5.6. Raising Public Awareness of the Environmental Issues

Awareness of environmental issues can be raised by promoting educational approaches to encourage pro-environmental behaviors (e.g., educating the public about the relationship between economic development and environmental degradation), institutionalizing public participation in environmental decision-making, and increasing the disclosure of environmental information to inform people about environmental conditions (e.g., local radio stations and broadcasting can be used to provide information about local environmental topics, management, or species protection).

Overall, the finding above indicates that ensuring sustainable utilization of environmental resources calls for a holistic approach to tackling the problem of poverty in such a way that avoidable damages to the environment could be averted. Indeed, no society can address the social phenomenon of sustainable development in isolation from the twin problems of poverty and environmental degradation. Poverty caused by environmental degradation is inextricably linked to the unsustainable use of natural resources. In order to remedy the situation, policymakers must prioritize environmental protection over poverty alleviation. It is necessary to determine if poverty is internal or external. If it is internal poverty, then environmental policy must be prioritized. However, if external poverty exists, poverty reduction programs must be developed.

Cross-sectoral policy adjustments are required to enable and catalyze Madagascar's capacities instead of increasing dependence on external actors such as the World Bank, the International Monetary Fund, and donor countries, as well as to improve the livelihoods

and wellbeing of the country's rural poor [22]. The government should allocate sufficient funding for the smooth running of literacy programs and ensure that people acquire knowledge that will help them protect the environment.

In summary, these strategies will contribute to solving the environmental issues and to achieving the SDGs in Madagascar (See Figure 7).

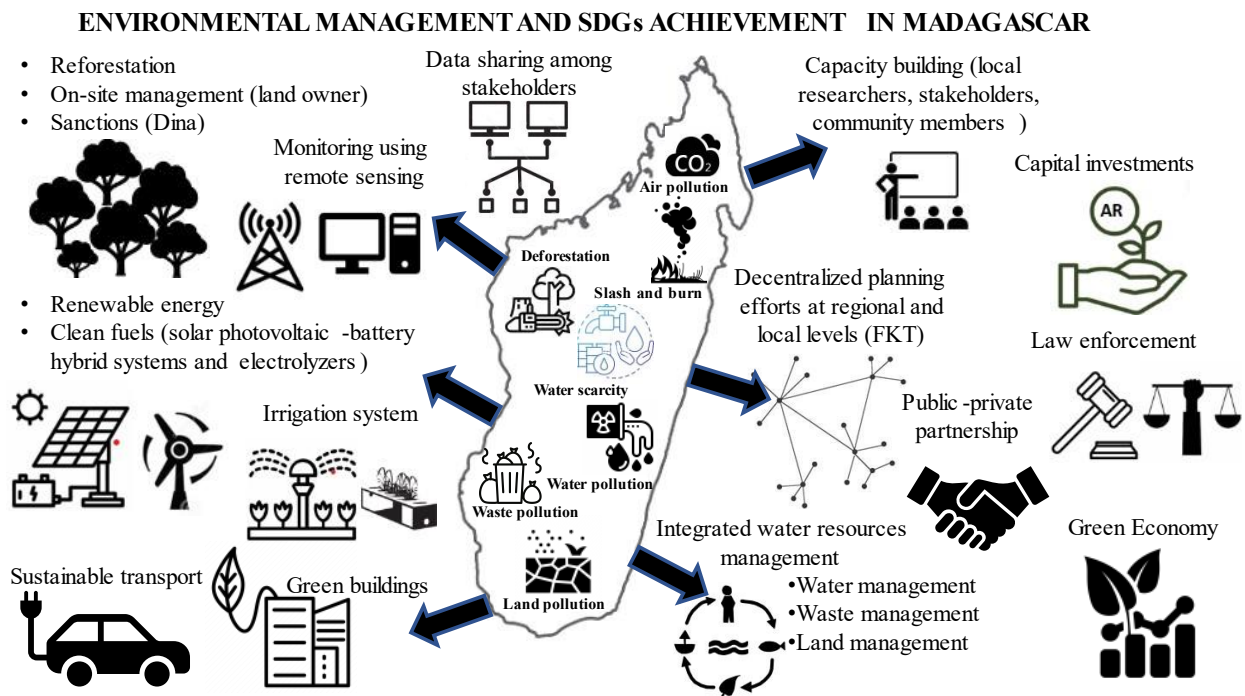


Figure 7. Strategies for solving Madagascar's environmental problems and achieving the SDGs (Source: Authors).

6. Conclusions

Environmental action is inseparable from actions for the sustainable economic and social development of the country; therefore, environmental protection should contribute to poverty reduction and nourish and "sustain" economic growth. This paper discusses Madagascar's achievements of the sustainable development target with special emphasis on environmental issues, which is currently a major concern in the country. This review aims at suggesting improvements in line with the challenges the country is facing by reviewing the indicators provided by the UN SDGs. In order to conduct this study, journal articles, review papers, working papers, research reports, and books related to environmental management and sustainable development in Madagascar were reviewed. We found that Madagascar's environmental policy is in line with the SDGs to maintain the balance between population and resource development. However, the development and implementation of the Environmental Action Plan have not significantly reduced the degradation of natural resources in Madagascar. The complex relationship between environmental degradation, population, and poverty has provided enough evidence that sustainable development and protection of the environment cannot be achieved through good environmental planning of development projects alone unless certain support of particularly good quality environmental properties is continuously available.

In summary, forest fires and slash-and-burn were on the rise in Madagascar on October 2022, which poses a major concern for the economic and social development of the island. Many policy changes have been implemented to address both environmental conservation and development issues, but these efforts have had little impact on the SDGs' achievement. This review suggests that promoting a sustainable environment in Madagascar needs particular changes in behavior. People should be aware of the effects

of environmental issues and ensure that future generations have a healthy planet to live on. In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it. The concern about sustainable development should consider critical factors that influence its achievement since development concerns present and future generations. The future relies on individual and national initiatives. Implementing appropriate legislation and politics could save Madagascar from the human side of environmental issues and ensure sustainability. The strategies proposed in this paper might be helpful for the Malagasy government and private sector in decision-making. This paper is also useful for researchers in developing countries. As Madagascar did not reach the Millennium Development Goals 2015 and will not achieve the SDGs in 2030, should we not start learning from our mistakes and thinking about the post-SDGs?

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