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To cite this article: A. Colangelo, A. Perazzone, C. Giacoma, R. M. Randrianarison, J. Ratsimbazafy, R. S. Zoeline, S. Rakotonomenjanahary, H. Rasamimanana, K. Dell'Aira, C. Spiezio, C. Avesani Zaborra, D. Valente, C. De Gregorio, G. L. Beccaro, V. Torti & M. Gamba (2025) A forest path towards an education for global citizenship, *The European Zoological Journal*, 92:1, 210-226, DOI: [10.1080/24750263.2025.2451176](https://doi.org/10.1080/24750263.2025.2451176)

To link to this article: <https://doi.org/10.1080/24750263.2025.2451176>



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Published online: 28 Jan 2025.



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A forest path towards an education for global citizenship

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(Received 6 December 2024; accepted 2 January 2025)

Abstract

Long-term zoological and ethological field research plays a substantial role in developing effective biodiversity conservation actions. At the same time, stable research facilities in areas where subsistence economies prevail foster the development of relationships and ongoing collaboration with public and private institutions. This study focuses on the local impact produced by Maromizaha Research Polyvalent Center –CRPM–, a field station located in eastern Madagascar, where, since 2008, the Department of Life Sciences and Biology Systems at the University of Turin has led ethological research programs on various lemur species, working closely with the Manager of the Protected Area, GERP, and the local population. Over the years, this facility has generated opportunities for professional training, capacity building, and educational projects in the Anevoka primary schools. In 2024, the incredible biodiversity of the Maromizaha forest became the focus of the educational project "Tonga Soa Madagasikara!" (Welcome to Madagascar!) which involved Malagasy children and young people, as well as a middle school class from the Rimini province in Italy. Zoological research activities gradually evolved into international cooperation projects in educational fields, effectively integrating indigenous knowledge and diversifying livelihood options to reduce dependency on biological resources. Collaborations promoted by shared research goals contributed to local educational and economic growth, and contributed in strengthening the local communities. In conclusion, efforts to enhance local environmental sustainability and conservation in Maromizaha contributed to the achievement of several Sustainable Development Goals, such as SDG 4 (Quality of education) and SDG 15 (Life of land), but also to SDGs 2 (Zero hunger), SDG 3 (Good health and well-being), SDG 5 (Gender equality), SDG 10 (Reduced inequalities), SDG 12 (Responsible consumption and production), SDG 17 (Partnership for the goals) and 13 (Climate actions). The Maromizaha long term cooperation project shows how, thanks to scientific research, education for sustainable development becomes education for global citizenship in disadvantaged areas of the world.

Keywords: Sustainable development, SDG 4 quality of education, Madagascar, Maromizaha field station, SDG 15 Life on land

Sustainable Development Goals: SDG 15: Life on land

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Introduction

Madagascar represents one of 36 biodiversity hotspots in the world (Myers et al. 2000). The island hosts an extraordinary variety of endemic species, found nowhere else on the planet. Almost 90% of the plants and about 85% of the animals are endemic to the island (Goodman & Benstead 2005). This biological uniqueness resulted from millions of years of geological isolation, which has allowed the evolution of unique flora and fauna since Madagascar split from Africa 150 to 160 million years ago (Ali & Aitchison 2008).

Madagascar's fauna is particularly notable for its diversity and uniqueness. Among mammals, lemurs have diversified into over 100 species, including *Indri indri*, the only existing singing lemur (Pollock 1986; De Gregorio et al. 2022). Endemic carnivores, such as the fossa (*Cryptoprocta ferox*), are also emblematic to the Malagasy fauna. Madagascar is also a true paradise for herpetologists, with over 400 species of reptiles, including chameleons, geckos, and snakes (Glaw et al. 2022), and about 300 species of amphibians, primarily endemic frogs (Amphibia Web 2020). Malagasy birds are no less spectacular, with over 200 species, about 40% of which are endemic (Goodman & Benstead 2005). The island's rich freshwater fish fauna and the countless invertebrate species, including some of the most colorful insects, also contribute to its extraordinary biodiversity in a way that still needs to be thoroughly investigated.

Sadly, most of the extraordinary Malagasy fauna is threatened with extinction. The island's biological richness is indeed under increasing threat due to human activities, including climate change. Primary causes are slash-and-burn agriculture (Scales 2011), overexploitation of natural resources, and charcoal production (Vieilledent et al. 2018). These activities are mainly carried out to satisfy basic needs such as cultivating and cooking. Nearly 90% of the original natural vegetation has been destroyed, and new results show that deforestation has increased dramatically (Vieilledent et al. 2018). Fragmented forests can only host small populations of animals that can quickly die out if the forest patch is too small to maintain a viable population (Saunders et al. 1991). Zoologists, botanists, and conservation biologists are active in Madagascar, producing reports and scientific papers contributing to understanding and managing biodiversity. A crucial step is now represented by the involvement of local people in creating sustainable development projects that could help them meet their needs without jeopardizing biodiversity.

The case study presented here involves scientific research activities directly linked to various targets of SDG (Sustainable Development Goals) 15: "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and biodiversity loss" (United Nations 2015). Since the early 2000s, a stable scientific research station, notably the Maromizaha Research Polyvalent Center - CPRM - has strengthened international partnerships (Goal 17 of the 2030 Agenda) and embedded itself within the socio-cultural fabric of a particular area of Madagascar: the Maromizaha New Protected Area (hereafter NPA), inside the Ankeniheny-Zahamena forest corridor. The impacts have been multifaceted, allowing for direct and indirect alignment with many other goals and targets, especially Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (UN 2015, p. 17). Scientific research projects, funded within the area, have helped strengthen educational infrastructure, trained qualified teachers at the Anevoka Primary School and expanded the number of scholarships for enrolment in higher education, including vocational training (Targets 4.a, 4.c e 4.b). However, in this context, we also wish to focus on Target 4.7, specifically providing individuals with the knowledge and skills needed to promote sustainable development.

Sustainable development and global citizenship

Education for Sustainable Development (ESD) naturally integrates with Global Citizenship Education (GCED), as clarified in a significant UN Educational, Scientific and Cultural Organization (UNESCO) document from 2017 titled *Education for Sustainable Development Goals: Learning Objectives*: "ESD is explicitly recognized in the SDGs as part of Target 4.7 of the SDG on education, together with Global Citizenship Education (GCED), which UNESCO promotes as a complementary approach" (UNESCO 2017).

This educational complementarity, now officially established, between environmental and citizenship themes has deep roots. However, GCED and ESD continue to be discussed separately and are often viewed as distinct in terms of both knowledge content and value systems (Perazzone et al. 2024). ESD is still understood as relating to environmental issues and respect for the natural environment, sometimes in opposition to human-centric contexts. Conversely, GCED emphasizes values such as solidarity and international cooperation,

focusing on cultural issues, lifestyles, and development models of human societies without substantial reference to territory, climate, or access to natural resources.

Cognitive aspects are more directly associated with ESD, while socio-emotional aspects align more closely with GCED (UNESCO 2019). Thus, ESD primarily addresses the dissemination of ecological knowledge, whereas GCED focuses more on issues of social inclusivity. In our view, the socio-emotional component should cultivate empathy, solidarity, and respect for humans and non-human life, fostering a sense of belonging to our planet and responsibility for its future as a shared home for all forms of life.

Educationally, fostering everyone's ecological identity - the ability to feel connected to the rhythms of the Earth and the ecologically productive ecosystems on which we depend (Thomashow 1996) - can help to develop a genuine sense of global citizenship. Such citizens feel invested in environmental issues, rather than simply delegating their resolution to experts (Bertolino & Perazzone 2018). Edgar Morin, perhaps more than any other thinker, effectively synthesizes these two educational fields through his concept of planetary humanism (Simonigh 2012), promoting a "terrestrial identity" (Morin 1999) that strives to reorganize thought and education in a transdisciplinary way. Addressing the connections between GCED and ESD, rather than their distinctions, seems particularly significant for realizing education's transformative power, which should always be forward-looking and oriented towards change and action, with the potential to shape behaviors and worldviews.

This vision of *Re-imagining Our Futures Together*, also the title of an influential 2021 UNESCO publication, underscores the transformative power of education and redefines its goals with a critical eye toward current educational systems (UNESCO 2021). For this transformation to happen, each field of knowledge must recognize and incorporate other essential values and foster the global competencies needed to face future challenges. Developing systemic thinking within an inter- and transdisciplinary perspective is necessary for cultural and educational systems to undergo the profound change required to comprehend our present world, with one of its imperatives being the unity of knowledge (Colucci-Gray et al. 2013).

This collective effort, uniting scientific research, outreach, and education, underlies this case study, which also seeks reciprocity between the initiatives in Madagascar (Giacoma 2014) and those we could develop in Italy.

The role of zoologists: from biodiversity conservation to education and science outreach

The importance of including local communities in conservation and environmental sustainability programs is well-supported by extensive literature (Funtowicz & Ravetz 2000; Brown 2003; Grainger 2003; Lucrezi et al. 2019), which also highlights that there are no simple solutions and that integrating conservation goals with community needs is a complex and thus necessarily lengthy process. Conservation investments are unlikely to be effective if economic, social, and political factors push in the opposite direction. For this reason, stakeholder participation should be supported by a flexible approach that adapts to the decision-making context, aiming at shared goals rather than those dictated by power dynamics (Guibrinet et al. 2021).

These considerations certainly pertain to justice and social equity (Goal 16 of the 2030 Agenda) but also resonate with those engaged in biodiversity conservation (Goal 15). The dynamics of these processes are like those within ecological systems: complex, non-linear interactions between various elements at different scales, all vital for the resilience and survival of ecosystems whose balance is anything but static. Addressing this requires developing systemic thinking and incorporating the value of diversity beyond the biological level. In this sense, diversity management - a set of policies and practices to recognize respect and value differences - is certainly familiar to natural scientists. The increased risk of misunderstandings and conflicts inherent in more complex working groups is counterbalanced by their enhanced capacity to handle uncertainty, thanks to the creativity stimulated by people's diverse backgrounds (Ferrante et al. 2022). The key to these practices is genuine and meaningful involvement, emphasizing empowerment, equity, trust, and cooperative learning (Reed 2008). Regarding this latter aspect, the suggestion is to incorporate Indigenous Knowledge Systems (IKS) and thus connect formal education with Indigenous epistemologies on one side and scientific research on the other (Al-Mansoori & Hamdan 2023).

This is only possible when conservation projects have continuity over time and research structures become rooted in the territory, as part of the social network (de la Torre & Morelos-Juárez 2022). Researchers can gradually assume multiple roles extending beyond their original scientific focus, converging towards the conservation goal and ensuring greater success. Zoologists, ecologists, sociologists, anthropologists, educators, and science communicators, who, by living in these places, come to

understand more readily the importance of fostering a shift in how fragile ecosystemic balances are perceived. Scientific explanations alone are not sufficient, nor is it enough to merely communicate the “beauty” of biodiversity. Disconnection from the environment, particularly the natural environment, is one of the greatest challenges we face, and education can help address it by bringing focus back to local places and phenomena. These form the foundation of experience and serve as the gateway to more distant and abstract knowledge (Smith 2002). Biodiversity must be explored in its specific locations and the local relationship with the environment should be the starting point for a deeper understanding of global issues.

It is therefore essential to promote direct experiences that involve active engagement, allowing for the development of contextual and local knowledge (Jiménez et al. 2014; Mortari 2020) and cultivating a sense of place (Ardoin 2006). Place-based education (Gruenewald 2003; Smith & Sobel 2010), where place and community are the educators, serves as a context that conveys values and becomes a space for participation and active citizenship, impacting both social and ecological well-being. Without outreach activities and educational projects capable of integrating aesthetics, expert knowledge, local knowledge, and direct experience of places, it will be impossible to develop a multidimensional understanding of biodiversity that connects environmental dimensions with social and economic aspects (Navarro-Perez & Tidball 2012).

Maromizaha conservation: historical background

In 2001, the management of the Maromizaha forest, a biodiverse and ecologically significant area in Madagascar, was entrusted by Madagascar’s General Directorate of Water and Forests to NAT (*Natur und Artenschutz in den Tropen*), a German research organization. This partnership aimed to describe Maromizaha biodiversity and leverage local expertise in tropical conservation to safeguard the forest’s rich natural resources. The forest itself is home to a wide variety of species, including several endemic primates, and urgently needs protection from environmental degradation, illegal logging, and unsustainable resource use. NAT’s role was to apply scientific research and conservation techniques to promote legal protection of the forest and sustainable management practices while engaging local communities in preserving the forest’s ecological value.

NAT’s stewardship lasted until 2007, after which the management responsibilities transitioned to GERP (*Groupe d’Étude et de Recherche sur les Primates de Madagascar*), a Malagasy organization with specialized expertise in primate research and forest management. Decision No. 197/2008/MEF marked a turning point for Maromizaha. GERP took on the challenge of building on NAT’s initial work while adapting conservation strategies to fit the local context better. The transition from international to national leadership in forest management reflected broader trends in conservation toward more localized governance, with a stronger focus on empowering local institutions to take charge of their natural resources.

From 2008 onwards, this new management model’s positive and negative impacts began to emerge. The designation of Maromizaha as a New Protected Area (NPA) candidate introduced significant changes in law conservation status and, consequently, how the 1850 ha of forest was managed. New rules governing access and resource use were implemented to regulate human activities within the forest and prevent overexploitation. However, these rules also placed restrictions on local communities, who traditionally relied on the forest for their livelihoods, such as harvesting timber, collecting medicinal plants, or practicing small-scale agriculture. Balancing conservation needs with the surrounding communities’ socio-economic needs became one of the critical challenges for GERP as it sought to implement sustainable management practices. To cope with those emerging issues, Torino University (hereafter “UNITO”) established a collaboration with GERP from the very beginning, resulting in the European project BIRD (Biodiversity Integration and Rural Development; ACP S&T - FED/2009/217077), putting the basis for the community-based management of the Maromizaha forest. UNITO’s and GERP’s approach to resolving these issues has involved strengthening community engagement and developing co-management frameworks, where local communities actively manage the forest and its resources. Over time, this participatory approach has helped build trust and collaboration between conservation authorities and local people, ensuring that conservation efforts are more sustainable and culturally sensitive.

Furthermore, the GERP-UNITO cooperation also increased international collaboration, with a focus on describing local biodiversity and development projects. These projects aimed to create alternative sources of income for local communities, reduce pressure on forest resources and support local education and biodiversity conservation. For

instance, many research opportunities were introduced to showcase the area's unique biodiversity, particularly its rare and endemic primate species, such as the critically endangered lemur Indri (*Indri indri*). These projects provided scientific knowledge, training, and economic opportunities for local people and helped raise global awareness about the importance of conserving Madagascar's forests (Giacoma et al. 2012; Giacoma & Beccaro 2017).

Overall, the 2008 transition marked a crucial phase in managing Maromizaha, where international scientific expertise was handed over to a Malagasy institution to navigate the complex dynamics between conservation needs and community development. The NPA status reached in 2015 (Decree No. 2015-783 of April 28, 2015) not only provided a legal framework for enhanced protection but also opened the door for broader international partnerships and the development of projects aimed at sustaining both the ecological integrity of the forest and the well-being of the people depending on it. However, this transition highlighted the challenges of balancing conservation goals with local needs. This dynamic continues to evolve as Maromizaha strives to become a model for sustainable forest management in Madagascar (Gamba et al. 2013; Randrianarison et al. 2015).

One of the most impactful initiatives was the official recognition by the Malagasy state of the three VOIs (Ampangalantsary, Morafeno, and Ambavaniasy), as well as the establishment of co-management structures that integrated the local communities into the governance of the protected area. These structures include a management platform (composed of the representatives of GERP, the 3 Village Organization for Institutional Transfers, or VOI, around the NAP and the traditional authorities), as well as the *polisn'ala* (forest police in charge of patrolling the NAP), which together oversee the transfer of natural resource management to the local level. By formalizing the role of these local bodies in 2016, GERP sought to empower communities to take an active role in the sustainable management of their natural resources. The equipment, infrastructure, and ongoing capacity-building activities were crucial in ensuring that the communities could manage the forest effectively and meet the responsibilities defined in their management contracts.

Maromizaha research polyvalent center -CRPM-

To raise awareness and promote education within the rural community of the ten villages surrounding Maromizaha NPA, the Maromizaha Research

Polyvalent Center -CRPM- was constructed inside the forest, just a 40-minute walk from the Route Nationale 2, which connects Antananarivo to Toamasina. The creation of this center in 2009 was made possible by significant co-financing from *Parco Natura Viva* - Garda Zoological Park, a modern zoological garden and a breeding centre for endangered species based at Bussolengo (Italy) and to the ACP S&TI "BIRD" Project (Contract N° FED/2009/217077). The Maromizaha CRPM is a critical hub for environmental education and outreach activities, providing a space for learning, community engagement, capacity building, research, and conservation initiatives.

The CRPM's role became even more pronounced by connecting GERP's community-based approach to biodiversity research and conservation with rural development. By focusing on both biodiversity conservation and the needs of rural communities, the project aims to balance ecological preservation with sustainable economic growth, ensuring that local populations benefit from conservation efforts while actively participating in them (Randrianarison et al. 2015).

The CRPM hosted plenty of training and educational activities involving local people and staff from other natural areas, students and researchers of Malagasy and international universities doing field courses and data collection for their theses. The collaboration between universities, conservation organizations and local communities, facilitated by CRPM, demonstrates a holistic and multi-actor approach to environmental conservation, which seeks to preserve natural habitats while uplifting and empowering the people living in proximity to these critical ecosystems. The multi-purpose center is not just an educational facility but rather a symbol of cross-border collaboration and shared commitment to biodiversity conservation. Such a center in the Maromizaha forest helps bridge the gap between global conservation efforts and the everyday realities of the local community. It provides a tangible space for the Maromizaha Conservation project's initiatives to unfold, from community education to hands-on training in sustainable agriculture and biodiversity management. The center acts as a facilitator for the development's broader objectives of integrating conservation with rural development, ensuring that the preservation of the forest goes hand in hand with improving the livelihoods of the nearby people (Table I, Professional Training, action PT1, PT2, PT3).

By engaging the Anevoka community in this way, the project fosters a sense of ownership and

Table I. Detailed description of all the educational activities led by UNITO and GERP, together with all the Malagasy donors and international funders.

ACTIVITY	DESCRIPTION	YEAR OF START	YEAR OF ACCOMPLISHMENT	MAIN SPONSOR
Professional training - Agenda 2030: goal 4. b				
PT1 30 research guides	Research guides have been trained about local biodiversity and main field monitoring techniques (animal population surveys, botanical censuses, passive acoustic monitoring and camera trapping, transects surveys, etc.).	2008	ongoing	BIRD (ACP S&T - FED/2009/217077) EU funds - Turin University FIHAVANA https://www.ottopermillevaldese.org/resoconto/Mulhouse_Zoo https://www.zoo-mulhouse.com/en/home/ UIZA Network https://uiza.org/ PNV https://www.parconaturaviva.it/
PT 2 2 field station managers	Field station managers have been trained to be the contact persons in charge of managing the Maromizaha CRPM and administering the forest refuges.	2009	2012	BIRD (ACP S&T - FED/2009/217077) PNV https://www.parconaturaviva.it/
PT 3 18 touristic guides	Eco-touristic guides' training is focused on principles of responsible, community-based ecotourism and management of tourism-related environmental impacts.	2010	ongoing	BIRD (ACP S&T - FED/2009/217077) GERP https://www.association-gerp.org/ PNV https://www.parconaturaviva.it/ Fondazione A.R.C.A. https://fondazionearca.eu/
Structure improvement - Agenda 2030: goal 4. a				
1 Support for infrastructure rehabilitation of school supplies	We built facilities at the Anevoka EPP (classrooms, library, kitchen, toilets), installed solar panels, and repaired the teachers' building roof and children's toilets, which were damaged in 2020. As the lack of educational materials hinders school attendance, together with GERP, we provide school kits to students using funds from several donors (Rotary, A.R.C.A., GTTF, WSO, ASLM, etc.).	2010	ongoing	Rotary - AROALA project https://www.rotary.org/it/about-rotary/rotary-foundation A.R.C.A. https://fondazionearca.eu/ GTTF https://greententeam.org/ WSO https://www.wsogroup.org/ ASLM https://www.aslm-lemuriens.com/
2 School Library	Installed in 2017, with funding from GTTF and LVDI Inc., it was renovated in 2023. New furniture (UNITO, ARCA, GTTF) and books (ASLM) were purchased. Distribution of reading books on lemurs, the AKO series and the EAZA book "Un lemure da salvare"	2015	ongoing	Santi Family GTTF https://greententeam.org/ LVDI Int. https://lvdiinternational.org/ UNITO https://www.unito.it/ U ONLUS https://www.rotary.org/it/about-rotary/rotary-foundation EAZA Madagascar campaign

(Continued)

Table I. (Continued).

ACTIVITY	DESCRIPTION	YEAR OF START	YEAR OF ACCOMPLISHMENT	MAIN SPONSOR
Encourage attendance by supporting - Agenda 2030: goal 4. b e 4. c				
4 School Canteen	Apart from financing the canteen (UNITO, LVDI, GTTF, Waldensian Evangelical Church, ASLM), we equipped the school with an educational garden, whose products provide essential nutrition.	2010	ongoing, but occasional	GTTF https://greenteenteam.org/8x1000 Waldensian Church https://www.ottopermilvaldese.org/resoconto/
5 Teaching staff direct support	a) U ONLUS and GTTF supplied the salaries for 3 FRAM teachers. b) Complementary environmental training has been provided under the supervision of ENS and the Rotary Foundation	a) 2022 b) 2015	ongoing	GTTF https://greenteenteam.org/ Rotary - AROALA project https://www.rotary.org/it/about-rotary-rotary-foundation ENS http://ens.univ-antananarivo.mg/ GTTF https://greenteenteam.org/ A.R.C.A. https://fondazionearca.eu/
6 Pupils school fees	Grant for schoolchildren/students coming from families involved in conservation activities	2018	ongoing	Peace Corps https://www.peacecorps.gov/madagascar/ ASLM https://www.aslm-lemuriens.com/ ASLM https://www.aslm-lemuriens.com/
Educational improvement - Agenda 2030: goal 4.1				
7 Outdoor activities	ASLM and Peace Corps promote physical fitness through football, jump rope, dance clubs, theater, and more.	2016	ongoing	Peace Corps https://www.peacecorps.gov/madagascar/ ASLM https://www.aslm-lemuriens.com/ ASLM https://www.aslm-lemuriens.com/
8 Playful learning	“The Lemur Path” from ASLM promotes Lemur-themed bingo, memory games, quizzes, and other activities that encourage learning through playful methodologies.	2018	ongoing	LVDI Int. https://lvdiinternational.org/
9 Little Green Guards® Program of LVDI International	The Malagasy Little Green Guards® Program of LVDI International was launched in 2015 for the Anevoka Primary School. Teaching materials and activities were created to improve children’s academic skills while fostering a deeper appreciation for the local forest. One successful tool was the Little Green Guards® Animal Biology and Conservation (ABC) Coloring Book, which enhanced students’ understanding of wildlife and improved academic performance in 98% of participants. A Malagasy children’s storybook, <i>Ny Alan’ny Hazo Hasinabe (The Forest of the Dragon Trees)</i> , was also created to strengthen their connection with nature.	2015	2019	U ONLUS https://www.uonlus.it/ WSO https://www.wsogroup.org/ GTTF https://greenteenteam.org/ A.R.C.A. https://fondazionearca.eu/ VOLOHASY project https://uiza.org/ https://www.uonlus.it/chi-siamo/progetti/
Education for Sustainable Development and Global Citizenship – Agenda 2030: goal 4.7				
10 Green Classes	Lessons inside the forest on biodiversity, functions, and ecological importance of the forest are given by the researchers and the guides at the CRPM.	2009	ongoing	U ONLUS https://www.uonlus.it/ WSO https://www.wsogroup.org/ GTTF https://greenteenteam.org/ A.R.C.A. https://fondazionearca.eu/ VOLOHASY project https://uiza.org/ https://www.uonlus.it/chi-siamo/progetti/

(Continued)

Table I. (Continued).

ACTIVITY	DESCRIPTION	YEAR OF START	YEAR OF ACCOMPLISHMENT	MAIN SPONSOR
11	Screening of environmental films and documentaries	2011	ongoing, but occasional	GERP https://www.association-gerp.org/
12	Waste management training	2016	2022	8x1000 Waldensian Church https://www.ottopermillevaldese.org/resoconto/ U ONLUS https://www.uonlus.it/
13	Reforestation projects	2018	ongoing	GERP https://www.association-gerp.org/ Rotary - AROALA project https://www.rotary.org/it/about-rotary/rotary-foundation WSO https://www.wsogroup.org/ Fondation Segré https://www.fondationsegre.org/ Fondazione ZOOM https://www.fondazionezoom.it/ ASLM https://www.aslm-lemuriens.com/
14	Storytelling of ecological tales	2018	ongoing	ASLM https://www.aslm-lemuriens.com/
15	Reading French Playlet on Nosong, the indri	2015	2015	Rotary - AROALA project https://www.rotary.org/it/about-rotary/rotary-foundation
16	raising awareness on healthy nutrition	June 2018	August 2018	Rotary - AROALA project https://www.rotary.org/it/about-rotary/rotary-foundation
17	Participation in regional and local events	Respectively in 2014 and 2021	ongoing	GERP https://www.association-gerp.org/

Here, we provide an activity description and a chronological framing. Information has been gathered from different sources (internal reports from UNITO and GERP, donors' websites, and the Environmental Education Activities Madagascar 2018 from https://en.wikiversity.org/w/index.php?title=Environmental_Education_Activities_Madagascar&oldid=181824).

responsibility among residents, encouraging them to take active roles in conserving the forest environment. Including local universities and research institutions, such as the Universities of Toamasina, Antananarivo, and Mahajanga, as well as local and traditional authorities, ensures that the project is grounded in local knowledge and expertise, making it more relevant and sustainable in the long term. Moreover, the support from international organizations underscores the global significance of preserving Madagascar's unique biodiversity and reflects the project's broad scope.

Education projects

To foster local sustainable development, environmental awareness and sense of citizenship, we have actively collaborated with local schools to identify local needs and improve student success in local primary schools. We have identified as crucial actions to improve school structures and desk availability (Table I, actions 1–3), to guarantee a salary to all teachers involved (Table I, action 5), to support the school attendance of pupils by canteen services (Table I, actions 4 and 6), the improvement of teaching (Table I, actions 7–9) and the integration of lessons to learn about the forest richness and biodiversity, with those on sustainable development and global citizenship (Table I, actions 10–17).

We started our support of the Anevoka Primary School in 2009. Our goal was to instill a deeper appreciation for nature and introduce biodiversity conservation activities into the curricula of over 250 schoolchildren. Recognizing that education is the key to long-term cultural change, we worked closely with students and educators to build a new sense of environmental stewardship. By incorporating lessons on the importance of biodiversity, conservation and sustainable land management into the primary school curriculum, we aimed to cultivate a generation that values and protects its natural surroundings.

Initially, education interventions were mainly aimed at raising environmental awareness among children through sporadic educational sessions with the teachers. In a second phase, actions were directed to involve the local community more deeply, and create a feeling of citizenship. Thanks to the **BIRD** Project, the University of Turin equipped both the CRPM and the Anevoka School building with solar panels, allowing the organization of public screening of films and documentaries of environmental subject (Table I, action 11). The Department of Agricultural, Forest, and Food Sciences team of

the University of Turin contributed to create an educational vegetable garden where children were introduced to eco-friendly agricultural techniques (Table I, action 4). These lessons aimed to plant the seeds of change in the adults of the future by teaching farming practices that maintain the health of the forest (Giacoma et al. 2012).

Actions relating to education for global citizenship were strengthened in 2007, when the EAZA regional representative for Italy, Parco Natura Viva (PNV) edited a story on “A lemur to save”. We narrated the story to Malagasy students and asked them to illustrate but most of them never saw lemurs. Green classes allowed direct contact with lemurs and Malagasy students made the drawings utilized to illustrate the “A lemur to save” booklet. This educational project received the “Arovako I Madagasikara Education Award”, for developing the most innovative and original school and/or public education programme or product in support of EAZA Madagascar Campaign 2006/07.

In 2011 we promoted the first twinning program between several primary schools in Italy and Madagascar. The program involved an exchange of letters and drawings in which children told each other about the beauties of their countries of origin. The letters were then published on the *Repubblica@scuola* website.

In 2014, in collaboration with U ONLUS and thanks to the support of the Waldensian Evangelical Church, we started organizing green classes in the Maromizaha CRPM, involving six teachers and about a hundred students each time (**FIHAVANA** and **MANDROSOA** projects). About two hundred schoolchildren of the Anevoka Primary School were engaged in drawing competitions and attended education sessions during which we distributed educational materials (kids). Our “Green classes” (Tan et al. 2014) are nature excursions led by local guides, researchers and teachers who introduce children to the animal and plant species of the Maromizaha NPA, with the aim of boosting their environmental understanding (Table I, action 10). We also involved the schoolchildren and their families in basic sanitary education, with the support of doctors from the Andasibe Hospital (JIRO project).

From 2014 to 2017, the project **AROLA**, funded by the Rotary International Foundation, aimed at strengthening the capacities to ensure primary education and literacy for all, by funding scholarships and professional training sessions in literacy and basic education, and targeting both students and teachers. In the meantime, the number of teachers in the Anevoka primary school was reduced

from 7 (2017–2020) to 6 (from 2021 until now), so that investing in pedagogical skills to promote more effective educational programs in the school became even more important and we gained important support from the École Normale Supérieure (ENS, University of Antananarivo). The distribution of the indri Nosong book of the Ako series stimulated competence acquisition (Table I, action 15). First, the pupils memorized and recited the texts in either Malagasy or French by expressing the appropriate emotions. This was a great challenge that they were able to meet with a spirit of both competitiveness and mutual aid. Students helped each other memorize words, especially in French, and pronounce them correctly. Secondly, attitudes of responsibility and solidarity were developed by making costumes and props to illustrate and bring the story to life. Making props required an appreciation of aesthetics and the practice of a scientific approach by evaluating the materials used in relation to the preservation of the environment. Using scraps of fabric to model and stuff the animal models and plastic bottles to represent insect wings mobilized their understanding of conservation against waste. Last but not least, this programme funded the construction of the school toilets (Table I, action 1).

Building upon previous interventions at the Anevoka primary school (EPP), the **FANABEAZANA** project was launched in 2018 with an initial funding from the A.R.C.A. and Green Teen Team Foundations. This program introduced a broader scope of educational support and represents a critical initiative to support the students who live permanently in the villages surrounding the Maromizaha forest. In particular, the project sought to extend its impact beyond primary education by also including secondary school students, to ensure that the local youth have a sustained opportunity to access education, which is crucial for personal development and long-term community growth. This project, alongside GERP's interventions in the area, addresses the pressing need for educational improvement and helps to bridge the gap between conservation efforts and community development. The project succeeded in supporting one young woman until university studies (Table I, actions 6).

One of the most remarkable aspects of the **FANABEAZANA** project is its synergy with environmental education initiatives. In 2022, the World Sustainability Organization (WSO) provided partial funding for the project through its *Friend of the Earth* initiative, contributing to scholarships and hands-on learning experiences within the Maromizaha forest, fostering a deep connection between the students

and their natural environment. This approach enhances their academic education and instills a strong sense of environmental stewardship. By learning about biodiversity, conservation, and sustainable practices within their local ecosystem, the students are better equipped to understand the importance of preserving the forest surrounding their community. We started with one green class in 2018, involving a restricted number of participants, to reach more than 100 students taking part in 2 or 3 green classes per year in 2023 (Table I, actions 10, 12, 14).

Over the years, the **FANABEAZANA** project's funding has covered a wide range of essential needs, ensuring that financial barriers do not prevent students from pursuing their education. The scholarships and annual tuition fees (see Table I, action 6) provided by the project have allowed many children to continue their studies uninterrupted, a critical factor in regions where education can be cost-prohibitive for families. In addition to tuition support, the project has also covered the cost of teaching materials, ensuring that classrooms are adequately equipped, and students have access to the necessary tools for learning (Table I, action 2). Furthermore, the project has provided financial support for food and lodging expenses (Table I, action 4), particularly important for students from more remote areas who need to travel to school. This holistic approach to support students living in deprived settings ensures that their basic needs are met, allowing them to focus on their studies without the burden of financial hardship.

Beyond individual scholarships, the **FANABEAZANA** project has also improved local primary school infrastructure and resources creating a more conducive learning environment for all students. In summary, by addressing educational and environmental needs, the project ensured that the next generation of local leaders is well-prepared to tackle the challenges of the future, equipped not only with formal knowledge but also with a deep sense of citizenship and inclusion, and empathy for the natural world around them.

This was also achieved through customized teaching materials and activities fostering children's academic skills and deeper connection with the local forest (Table I, actions 3, 7, 8, 9, 13, 14, 15), as well as through a positive learning environment fostered by the school library (Table I, action 3).

These efforts have yielded significant progress in children's environmental understanding, as demonstrated by their outstanding performance during the "questions for a champion" activity on Environment Day (from the Environmental Education Activities

Table II. For every academic year from 2013 to 2024, we report here the number of students who completed their annual course and moved to the next (from T1 to T5) in the Anevoka primary school.

Academic year	Pre-school	T1	T2	T3	T4	T5	TOTAL	Success Rate (%) at CEPE final exam
2013–2014	16	76	48	52	36	38	266	42,1%
2014–2015	16	65	58	60	30	21	250	97,14%
2015–2016	23	51	45	64	45	12	240	100%
2016–2017	27	75	48	49	57	16	272	50%
2017–2018	25	75	47	52	46	35	280	93,75%
2018–2019	19	47	55	42	48	18	229	100%
2019–2020	24	55	48	48	64	22	261	100%
2020–2021	26	75	53	41	45	31	271	87%
2021–2022	22	72	49	42	41	30	256	88%
2022–2023	22	70	37	56	33	24	242	92%
2023–2024	29	48	47	47	33	32	236	92%

Madagascar 2018 Report from https://en.wikiversity.org/w/index.php?title=Environmental_Education_Activities_Madagascar&oldid=1818248).

Moreover, it is relevant to notice the success rate at final examinations, which increased from an average 80% across 2013–2019 to 92% in the temporal span of 2019–2024. Besides this noteworthy reduction in school dropout, our actions allowed us to reduce the yearly oscillations that are the likely indicator of a fragile education system. While at the beginning we had pronounced fluctuations (with low peaks of 42% and 50%), across the temporal span of 2017–2024 the success rate has never fallen below 87% (Table II).

Another cause of fragility is age differences within the same class. Figure 1 shows the wide age span of pupils attending the same class. In the first class we have the youngest child aged 5 years together with the oldest which is 13 years old, resulting in 8 years of difference. This variability remains true over classes.

The “Tonga soa Madagasikara!” project: from Madagascar to Italy

“Tonga soa Madagasikara!” started in January 2024 and lasted until May 2024. It involved the Anevoka primary school and a 6th grade class (Italian *prima media*) from an Italian secondary school located in Bellaria—Igea Marina (Emilia—Romagna). Two 8th grade classes (Italian *terza media*) in the same school also received a two-hour lecture about life in Madagascar. We worked for two months in Madagascar, from February to March, and then in Italy from April to May 2024.

Activities in Madagascar

The Anevoka Primary School has an age-oriented classroom structure (tab 3/Figure 1). We worked

with 43 students from 9 to 17 years old. Anevoka classes are considerably larger than the Italian ones and the age gap is bigger (tab 3/Figure 1). 21 students were between 9 and 10 years old. The other 22 were mainly between 11 and 12, plus one student of 16 and one 17 years old.

There were two main learning objectives:

- Help students create a deep bond with the Maromizaha forest environment;
- Make students feel responsible citizens and integral to the Anevoka village community.

We focused on experiential learning activities about Maromizaha, its biodiversity, and the human-forest relationship. We chose the Green classes approach and organized three green classes in total.

Our activities were an effective attempt to integrate ESD (Education for Sustainable Development) and GCED (Global Citizenship Education). Not only did we aim to spread awareness about environmental topics such as plant names or lemur trophic chains, but also to help children become part of their community by interacting with adults working in the forest. We involved local workers who explained their everyday jobs to children, and most of the time we were accompanied by research guides who helped children in many activities. All the classes were led in *Malagasy*, Madagascar’s local language, in order to involve children more and make them feel confident about asking questions.

Our first green class took place on the edge of the Maromizaha forest. It was organized within the frame of the *Volohasy* project, which started in 2016 and aims to restore forest areas impacted by human activities by planting endemic bamboo. This is also a means of conservation for the bamboo lemur (*Hapalemur griseus*) suffering from habitat destruction

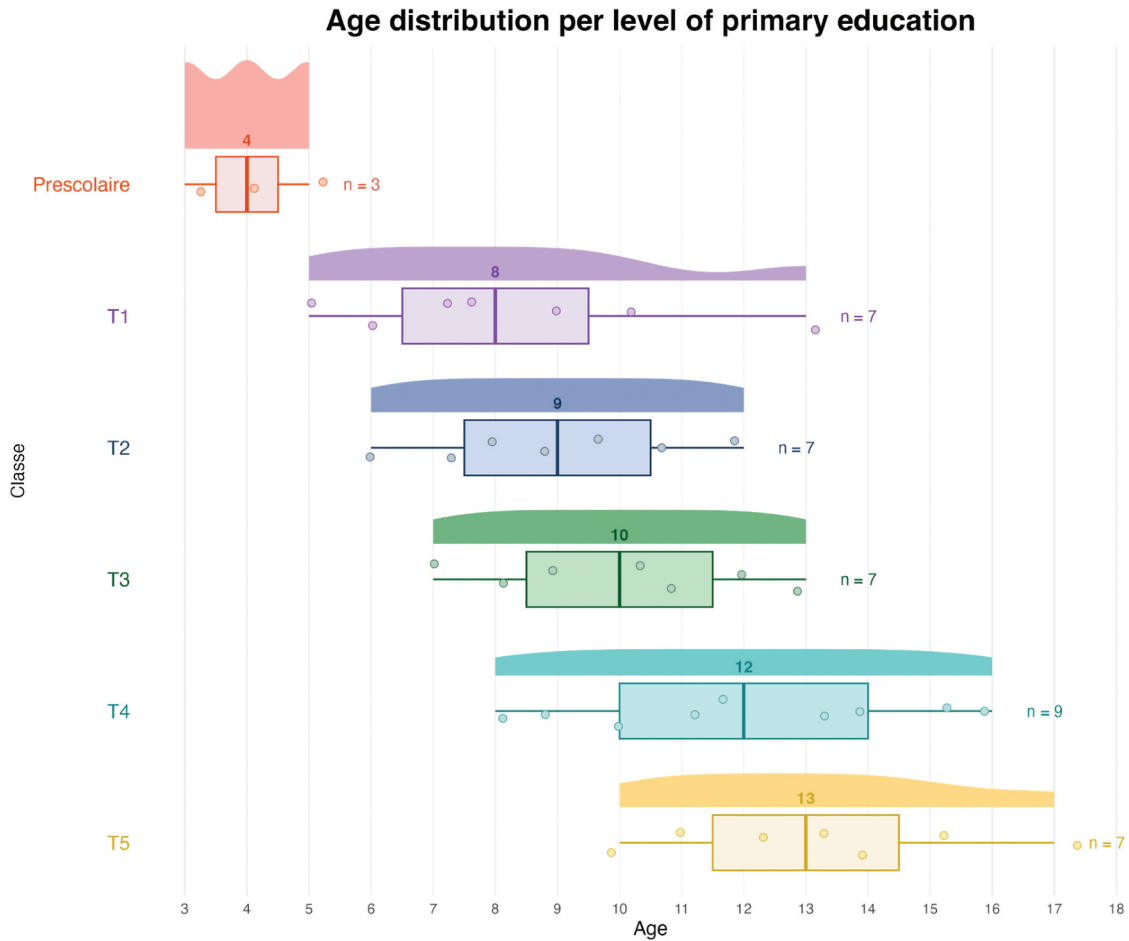


Figure 1. Age distribution in schoolchildren per primary education level (from preschool to fifth grade) within the Anevoka primary school in the a.Y. 2024/2025. X represents mean values.

and fragmentation. To achieve project objectives, we relied on a *pépinière*, a tree nursery where two local workers create new bamboo grafts every day and plant them in the forest once they are ready.

We took 22 students, aged between 9 and 10, to Volohasy *pépinière*. Here, the *pépiniéristes* explained their everyday job and why it is so valuable. Then, they showed the kids how to create new bamboo grafts from an older plant. Students worked very hard and in a single morning they created 62 new grafts. They learned how to care for them, gently watering them and making them sprout. After that, they carried ten already sprouted grafts into the Volohasy reforestation path inside the forest and planted them. We then left the *pépiniéristes* and came back to Anevoka school, where the children worked on an exercise provided by the project manager. Students had to link Maromizaha animal drawings to images of their favorite food and color every single image precisely. We then corrected the exercises, which was an excellent opportunity to discuss

children's biodiversity knowledge. On 22 exercise papers, only four presented mistakes, so almost 90% of the students completed it all correctly.

A second green class involved assembling herbariums: an original way to make students learn more about Maromizaha flora and its relationship with the local fauna, especially with multiple lemur species, including the critically endangered *Indri indri*, *Varecia variegata editorum* and *Propithecus diadema*. This activity was more complex than the first, so it was split into three different phases.

The first phase took place in February and involved 22 students between 11 and 16 years old. Two research guides led the students into the Maromizaha forest. Together with research guides, we walked Maromizaha trails and started collecting plant samples. Guides were told to target plants involved in lemurs' food chain and explained to students plant names and which lemur eats them. We also took some medicinal plants traditionally used in *Malagasy* medicine to

deepen children's cultural knowledge and heritage. The students took samples directly, with research guides' help. They put each sample in a different plastic bag. We collected samples from ten different species and at least five samples for every plant.

After our forest hike, we went to the Maromizaha Research Polyvalent Center -CRPM- where the students met the researchers and research guides who live there so they can do their daily work, collecting scientific data on Maromizaha lemurs. The students were curious about their work. We explained why we took plant samples and what a herbarium is. One by one children tried to prepare plant samples by treating them with an alcohol and water solution. This step is essential because the Maromizaha forest climate can reach a humidity over 90%, jeopardizing samples with mold. Then, children learned how to use the herbarium press. They laid down samples on paper and carefully covered them with the press. They were told we needed at least two weeks to see the results. Afterward, near the center, we involved the children in a more playful and movement-based activity: "Capture the Flag". In order to win, they had not only to catch the flag but also to answer questions about lemurs. The activity was very appreciated, and the children responded correctly to all the questions. Although questions were straightforward (i.e., what is the smallest lemur in Maromizaha), this activity allowed the project manager to evaluate their knowledge of the Maromizaha fauna.

The third phase took two weeks at Anevoka Elementary School, where we worked with 43 children in their classes. Two research guides and a class teacher worked with us during the activity. We split the class into five groups of 8/9 children each. We gave each group papers and tape. We also prepared all the dried plant samples on the teacher's desk. Samples were divided into species with plant vernacular names written on a label. Each group took at least five different samples and started taping the specimens on paper. Students wrote plant names and their peculiar traits near the sample. Research guides were essential in this phase since they constantly visited every group, helping students remember everything about plants. In the end, we were able to assemble five different herbariums, each with a minimum of five plant samples.

The third green class occurred at Anevoka Primary School on the same day as the herbariums assembling. Our two research guides, Ranaivomanana Jean and Rakotoarisoa Gilbert, started the activities by telling students about their job in the forest: how they became guides, what they had to study, what their daily and special tasks are, what satisfactions

and frustrations are part of their work. Children were very enthusiastic and had many questions. This kind of guidance activity will inspire some students to follow their path and engage in the protection of Maromizaha. Shortly after, the guides told children legends about Maromizaha forest. Anevoka village rises in the immediate vicinity of Maromizaha and many traditional stories, *tantara* in *Malagasy*, are about lemurs or other animals living in the forest. *Tantaros* are also often about human-forest relationships. This could be a fantastic opportunity to make children empathize with Maromizaha and safeguard Anevoka cultural heritage, mostly transmitted orally. Students were very excited and started to draw them after listening to the stories. They also wanted to write a summary of the chosen story next to the drawing. We collected a total of 43 drawings.

Activities in Italy

The "Tonga soa Madagasikara!" project also took place in Italy.

Our main objective was to raise awareness about this incredible country, its biodiversity, and its traditions. Activities took place in Bellaria—Igea marina, a city in Emilia Romagna, north-eastern Italy. We chose 26 children from a 6th grade class (Italian *prima media*) from the I.C. "IGEA". All children were between 10 and 11 years old. We worked during regular school science lessons since the project manager was also a professor in that school. The activities lasted 8 hours divided into three different moments.

The first phase lasted 3 hours. With photos, videos, and graphics, we introduced students to the complex reality of Madagascar. We started talking about the differences between an Italian student's life and a Malagasy one, which entailed very different lifestyles. Children were very involved and gained a lot of perspective about life in a country with a different development model. We also talked about differences between Madagascar's and Italy's landscapes and how different biodiversity realities could be born. Students had to reflect on evolution and how the environment shapes life forms. It was also a perfect occasion to explain the threats to biodiversity in Italy and Madagascar. The last two hours were dedicated to Maromizaha, its flora and fauna, and children's lives in the forest.

In the second work session, the children were engaged in independent research of information on the fauna of Maromizaha through the flipped classroom methodology. The 26 children were split into five groups. Every group received two Maromizaha animal species. The species were all vertebrates,

from amphibians to mammals. Every group had to search for information about the species and write a short presentation of every species. We encouraged students to make the presentation informal but precise in order to show it to their peers. This phase lasted 3 hours. A total amount of 10 presentations were made, focusing on the following species:

- *Mantella baroni*;
- *Phelsuma madagascariensis*;
- *Sanzinia madagascariensis*;
- *Brookesia superciliaris*;
- *Eulemur rubriventer*;
- *Haplemur griseus*;
- *Varecia variegata*;
- *Propithecus diadema*

We left out of the presentation the most peculiar Maromizaha lemur, *Indri indri* since the professor showed it to the students as an example. During the last phase, students had to expose their work to the rest of the class. It was a very important moment since every group did not search for information about other species, so all they could know was what their peers said about the animals. The activity was a success because all the children showed much interest in every presentation and asked many questions. It was a unique occasion to develop very peculiar abilities, such as finding information online and checking their veracity, working in a group, and splitting tasks.

The project ended with an activity that the children did independently during the summer holiday. As homework, they had to find some plants near their home and assemble a herbarium. In September, we examined each herbarium. They were indeed interesting and well assembled. We compared some of the plants they caught with Madagascar flora, reflecting on differences and what the species have in common. It was a great occasion to understand better how evolution shaped the flora to survive in different environments.

Discussion and conclusion

Education in Sustainable Development is a fundamental tool to promote biodiversity conservation and sustain the delivery of the Sustainable development Goals (SDGs). This is particularly true in a disadvantaged social context, such as Madagascar, where environmental education raises students' ecological awareness and can significantly impact local communities' sustainable development through a Global Citizenship educational approach. These efforts contribute to SDGs 15 (Life on land),

4 (Quality of education), 3 (Good health and well-being), 10 (Reduced inequalities), 12 (Responsible consumption and production), and 13 (Climate actions) and 17 (Partnership for the goals).

Madagascar is one of the poorest countries in the world. Activities that jeopardize nature and biodiversity, such as slash-and-burn agriculture or charcoal production, are mainly carried on to satisfy people's basic needs. The long-term zoological and ethological field research established in the Maromizaha protected area by Turin University and other partners represented an excellent opportunity to develop educational projects and other activities to sustain the local population by combining research and capacity building with education. Helping schools represents a very effective way to help local communities economically thus reducing anthropogenic pressure on the forest and setting an environment where children feel safe and willing to learn. In a context where many families struggle to meet essential requirements, supporting school attendance and teaching quality can reduce school dropout rates and promote a more prosperous and sustainable future for local communities.

Since 2009 we have been working in the Anevoka Primary School to promote children's deeper learning of nature and make them understand how important it is to protect it. We helped reduce the disadvantages due to poverty by looking for funds supporting toilet and classroom construction, teachers' salaries and student fees, and the school canteen. We took many approaches, such as green classes, storytelling and outdoor activities, to help students understand the delicate balance of the Maromizaha ecosystem and initiate them to biodiversity conservation-related activities. Our education activities have always been science-based and have contributed to SDG 4's (Quality education) targets by providing relevant learning opportunities for children and adults of both sexes. Our environmental education programs for children have been very well-received and have had positive results. Malagasy children are always eager to learn more and more since the teachers nurture them with scientific concepts by means of innovative teaching methods combining science and art. As Bransford et al. (2004) assert, the scientific training of any learner is an important part of the formal education, as it provides the intellectual tools and learning strategies needed to acquire the knowledge to think about being operational and productive, hence the need for scientific but recreational books and libraries. Taking children to the forest with activities that bring them closer to Maromizaha Forest, has an enormous impact on the actions they take every day

toward conserving this environment in their lives. After many years, the goal has remained the same: to make future adults conscious of the environment around them and willing to protect it, which aligns with Agenda 2030 development goals 15 and 4.

In 2024, we continued along this path with the “Tonga Soa Madagasikara!” project. We created green classes aiming to develop a deeper knowledge about Maromizaha and its biodiversity in children and, at the same time, made them interact directly with the local operators and research guides we trained, with the aim of creating a strong sense of community and active citizenship. We also worked to spread awareness about Madagascar and Maromizaha’s history and natural heritage in Italy, trying to make Italian children more aware of the threats and challenges their world faces. The next step could be to create a bond between schools in Madagascar and Italy, to create direct communication between children and raise their awareness about entirely different lifestyles, environments and cooperation.

In conclusion, efforts to enhance local environmental sustainability and conservation in Maromizaha contributed to SDG 4 (Quality of education) and SDG 15 but also to SDGs 2 (Zero hunger), 3 (Good health and well-being), 5 (Gender equality), 10 (Reduced inequalities), 12 (Responsible consumption and production), and 13 (Climate actions). The Maromizaha long term cooperation project shows how, thanks to scientific research, it is possible to combine and integrate the ESD and GCED approaches to conserve biodiversity in disadvantaged areas of the world.

Acknowledgments

We dedicate this paper to the loving memory of Rose Marie Randrianarison, who shared with us all these years of educational efforts and capacity building in the Maromizaha area, and who prematurely passed away on 28th October 2024. We are deeply grateful for her commitment.













This work was led by the University of Torino and was supported by many different colleagues and donors. The long history of educational involvement in Madagascar received enthusiastic support by so many individuals and organisations over many years that it is not possible to cite all of them individually. However, a special thanks to the colleague Giancarlo Bounous, whose scientific and practical support has been always present and fundamental. We publicly thank ACP S&T EU program, Fondazione A.R.C. A., ASLM Lémuriens, the EAZA Madagascar campaign, Fondation Segré, the Green Teen Team

Foundation, LDVI International, Mulhouse Zoo, USA Peace Corps, Parco Natura Viva - Garda Zoological Park, Rotary Foundation, RC Annecy-Tournette, RC Antananarivo Tsimbaroa, RC Chatel St. Denis, RC Torino Mole Antonelliana, the Santi’s Family, University of Torino, U ONLUS, UIZA, World Sustainability Organization, Fondazione Zoom and all the private supporters. Our thanks also goes to the Ministère de l’Éducation Supérieure et de la Recherche Scientifique (MESupReS) of the Malagasy government for the issuance of the permits related to the Maromizaha project. Special thanks to the Groupe d’Étude et de Recherche sur les Primates (GERP) de Madagascar, the current manager of the Maromizaha Protected Area, for all administrative and logistic assistance during the research period. We are grateful for the support of all the guides from the AGAM Association, the Ecole Normale Supérieure Antananarivo, the Anevoka Primary School Director and Teachers and all the schoolchildren’s families. We thank all the local people of Anevoka and the surrounding villages for participating in educational and capacity building activities. Finally, we address our warmth thanks to all the local authorities for their collaborative administrative assistance during our work in Maromizaha.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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