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Smart cooperation during CoVID-19 Pandemic: a case study in Nosy Mitsio Island (Madagascar)

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The majority of rural areas in developing countries live in a state of chronic emergency, due for the most part to the lack of sanitary assistance and food. Covid-19 aggravates this situation, complicating the action of International Cooperation in these countries. To this extent, the case study of the Nosy Mitsio island (Madagascar) is presented. The partnership between H4O, Kukula and Politecnico di Torino aimed to develop the design of a water supply system on the island, providing water for vegetable gardens and thus allowing the local population to achieve food self-sufficiency. The project was supposed to be implemented in 2020 before the Covid-19 pandemic happened. However, despite this major obstacle, the design started with a literature review and the data analysis of soil and water samples collected from the island. The relationship between the Covid-19 pandemic and the project development highlights the central role of smart cooperation: i.e., engagement, inclusion and participation of local communities and their professional training is essential for remote working of NGOs projects during the pandemic.
Keywords: Covid-19, international cooperation, Madagascar, WASH, agriculture, water resources, irrigation.

La cooperazione internazionale ai tempi della Pandemia da Covid-19: il caso studio dell'isola di Nosy Mitsio (Madagascar). *I paesi in via di sviluppo vivono in un continuo stato di emergenza, prevalentemente per la mancanza di cibo e assistenza sanitaria. La pandemia legata alla diffusione del Covid-19 ha aggravato tale situazione, complicando l'azione della Cooperazione Internazionale in questi paesi. A questo proposito viene presentato il caso studio dell'isola di Nosy Mitsio (Madagascar) sulla quale, attraverso la collaborazione tra H4O, Kukula e il Politecnico di Torino, era prevista la progettazione di un sistema di approvvigionamento idrico destinato all'irrigazione di orti per il sostentamento della popolazione. La situazione pandemica ha rallentato lo sviluppo del progetto di fatto permettendo unicamente una ricerca bibliografica e l'analisi di campioni di suolo e acqua provenienti dall'isola. La situazione ha messo in luce la necessità di adottare nuovi strumenti e nuove modalità di cooperazione, basati in primis sulla smart cooperation. Una buona relazione con i locali, la loro formazione e l'adozione, fin dalle fasi iniziali del progetto, di strumenti utilizzabili autonomamente dai locali, dovranno diventare, nel futuro, aspetti essenziali soprattutto nei progetti di Cooperazione Internazionale di piccola e piccolissima scala.*
Parole chiave: Covid-19, cooperazione internazionale, Madagascar, WASH, agricoltura, risorse idriche, irrigazione.

1. Introduction

The global Covid-19 pandemic and the consequent health emergency is particularly exacerbating the precarious pre-existing conditions of developing countries (Patel *et al.*, 2020). Indeed, most of the low-income countries already live in a chronic health emergency and the Covid-19 pandemic is only part of it. This scenario also affects the work and the impact of international cooperation, especially in rural areas where community development still relies on NGOs (Non-Governmental Organizations) and aid organizations actions. In those areas, the main constraint for the projects is that most of them are entirely led and run by expat staff. At present, due to the current impossibility for most of the expat staff to reach the spot where the oversea interventions take place, new considerations have to be taken into account.

For development projects, the importance of the local community engagement is undeniable. However, the success of the projects is often related to the output construction rather than the participatory approach according to which the projects are designed, implemented, and the way beneficiaries manage it in the long term. However, in a period like the Covid-19 pandemic, the capability of local communities to autonomously carry out the projects, together with the ability of the "western staff" to support them from remote are key factors for the project outcomes to be achieved.

Academic literature still lacks a set of indicators to measure a sustainable implementation of the projects and a protocol to follow in order to carry out the activities only with the remote support of the expat staff. This piece of research aims to gather relevant data from a Water Cooperation case study in northern Madagascar. In particular, the article aims to assess the methodologies that have been used to carry out a feasibility study for the design of a water irrigation system for a number of household vegetable gardens in a village of rural Madagascar. The research team wants to understand the main constraints, difficulties and also advantages and usefulness of the so-called *smart cooperation*. The result is a set of observations that may also be useful for similar projects.

2. Materials and methods

2.1. The Nosy Mitsio island

Nosy Mitsio is an island located 20 miles off the northwest coast of Madagascar in the Mozambique Channel (12° 54′ 0″ S, 48° 36′ 0″ E). The island covers a surface of less than 30 km^2 and the landscape is mostly hilly, its highest point is Mt. Ankarana, 206 m a.s.l. Nosy Mitsio is the only inhabited island of the Mitsio archipelago, with approximately 2,500 inhabitants (Antakarana ethnic group) distributed within 5 main villages: Bevaoko, Marimbè, Ampanitsoha, Ratapenjiky and Ampasindava (Figure 1).

Largely due to its off-grid location, the island lacks essential services and infrastructures. This makes the population highly vulnerable, especially with regards to health. The economic situation of its population is in line with the national trend: 77.6% of the inhabitants live below the poverty threshold, the Human Development Index (HDI) reaches only 0.521 and is ranked #162 out of 189 countries (UNDP, 2020). The villages lack basic services, such as access to drinking water and sanitation facilities. The only available water sources are few stagnant ponds located far away from the inhabited area. The only exceptions are the villages of Ampanitsoha and Bevaoko, which have access to drinking water since 2018 thanks to the *Tany Vao Project* (see next section). However, the whole population still practises open defecation, leading to a high morbidity and mortality rates for faecal-oral diseases (Nyoni and Nyoni, 2020).

The island economy is based mainly on fishing and goat/zebu farming. Livestock, instead of being consumed, are for the most part sold on the Madagascar mainland. Food availability strongly depends on weather conditions; when fishing is not possible, people only rely on rice and corn crops. The total lack of vegetables and the very low fruit availability has led to an unbalanced diet, with severe cases of malnutrition across the whole population. The households are very basic with no improved areas for food preparation and storage. Meals are prepared indoors on three stone open fires, which increase health risks especially for women and children due to their prolonged exposure to combustion fumes. In addition to the increased risk of respiratory diseases, open fires also represent a safety hazard and contribute to deforestation due to the large amount of firewood required.

Fig. 1 – Nosy Mitsio Island.

Agriculture in Nosy Mitsio is small-scale, subsistence farming. It is based on traditional knowhow and exclusively rain-fed. Most of Nosy Mitsio households directly depend on agriculture for their livelihood, however, their limited capacity to cope with shocks threatens food security and general well-being (Hertel *et al.*, 2010). Malagasy farmers generally lack basic services to be sufficient, such as a reliable water distribution for irrigation, which make them chronically affected by food insecurity (Harvey *et al.*, 2014).

The scarce availability of agricultural inputs, chemical fertilizers and improved varieties of seeds, along with the fact that only few farmers have ever received any technical training on crop production, make the entire community highly vulnerable. In Madagascar, small farms are exposed to a number of risks such as pests, disease outbreaks and extreme weather events, which undermines the owners' food and income security (Morton, 2007). Nosy Mitsio is no exception and local farmers face food insecurity and are vulnerable to external shocks.

In Nosy Mitsio agriculture activities follow the seasons: rainfalls are concentrated between October and April (rainy season) while are scarce from May to September (dry season). Each farming family usually owns several plots of slash-and-burn flat land for rice production and for few other agricultural crops, such as maize, manioc, vegetables, or fruit (e.g., coconut). Owing to the unsustainable land-use, almost all of the agricultural fields are severely eroded. On average, the slash-and-burn fields are cultivated for 3 years and are subsequently abandoned because of the soil depletion, weed invasion and a consequential low crop yield. As a direct result, new areas are regularly cleared from the primary forest for agricultural use, causing significant deforestation (Gaydes-Combes *et al.*, 2017).

The global temperature rising could be also a relevant risk for the local agriculture. Recent studies based on regional and global simulation models indicate that even moderate increases in temperatures will negatively impact on rice and maize cultivations (Rosenzweig *et al.*, 2014), which are the main cereal crops for Nosy Mitsio farmers. The low food security of Nosy Mitsio farmers due to the high exposure to a number of different risks, highlight the urgent need of permanent vegetable gardens with an efficient water distribution, which make them operative throughout the entire year.

2.2. Rainfall and weather data analysis

Madagascar has a tropical maritime climate that is influenced by the proximity to the sea, the altitude and the monsoons. Two main seasons are present: a hot season (from November to April) with heavy rainfalls and high levels of humidity, and a cool and dry season (from May to October). The average temperature along the coasts is between 23-27 °C, while in the internal area is between 16-19 °C (World Bank Group, 2021). In particular, the zone where the Nosy Mitsio island is located is characterized by a tropical climate (Köppen-Geiger classification Am – tropical monsoon climate).

Since a weather station is not located in Nosy Mitsio, rainfalls, rainy days and temperature data have been collected from different web sources (e.g., Cecchini, 2021; Merkel, 2020; WWCI, 2020). After a careful check of the source reliability and the possible presence of biases, the average monthly temperature, the rainfalls and rainy days have been calculated (Figure 2).

The maximum temperature ranges from 31°C in November to 29°C in August. The minimum temperature goes from 22°C in December to 18°C in June and July. Due to the sea presence, temperatures in Nosy Mitsio are generally higher than the average temperatures in Madagascar, but they show the same trend during the year. The monthly rainfall peak is in January (480 mm), while the minimum (34 mm) is in August. In Nosy Mitsio rainfalls follow Madagascar national trends, but they are more intense during the rainy season, and more moderate in the dry season. The total amount of rainfall in a year is about 2000 mm, even if there is a great variability between years: for this reason, a conservative and precautionary approach has been adopted, considering a variation of ±20% in the rainfall volume.

The frequency of rainy days follows the rainfall trend. The annual rainy days are 128 with 15-20 rainy days per month during the rainy season, and 0-5 rainy days per month during the dry season. Compared to the mainland of Madagascar, meteorological events in Nosy Mitsio are accentuated.

2.3. Hydrogeological characterization

The geological composition of Nosy Mitsio (as well as the whole Mitsio archipelago) consists of a volcanic bedrock. The lithological composition is made of acid and basic plutonic rocks and mixed sedimentary rock with a lateritic coverage (Roig, 2012). Ferralsol, also known as ferralitic or lateritic soil, covers around 10% of Africa and it is widespread in Central, Eastern, and Southern Africa, besides the

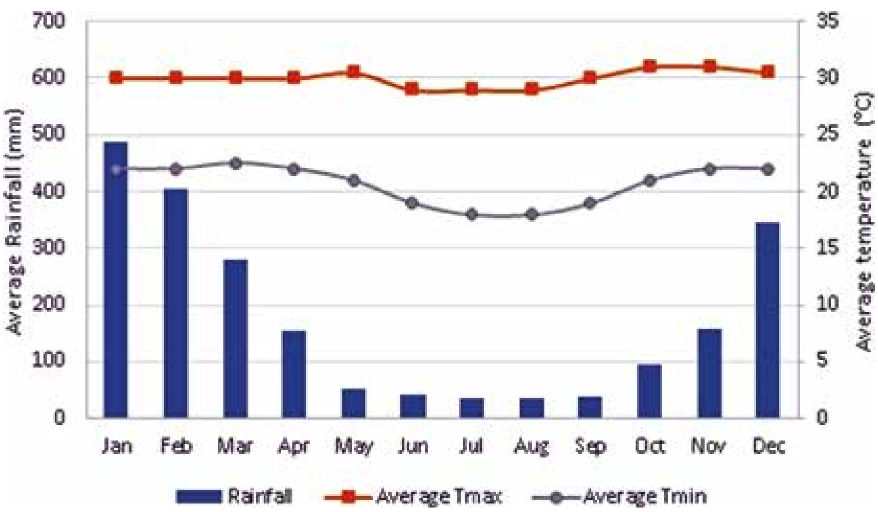

Fig. 2 – Nosy Mitsio Island: temperature and average monthly rainfall. Köppen-Geiger classification: Am – tropical monsoon climate.

north and east coast of Madagascar. Because of weathering, ferralsol is a leached soil with a very low content of nutrients, as calcium and magnesium, and a high content of aluminium and iron oxides (Dewitte *et al.*, 2013). Quartz is the only primary mineral present and as secondary minerals, there is a combination of kaolinite, gibbsite, goethite, and hematite. This type of soil has a low cation exchange capacity and a high anion absorptive capacity. The ferralsol appears red and patchy yellow-red, but in the upper layer is present a humus horizon, thanks to luxuriant vegetation, with a percentage of humus in the range from 1-1.15 to 8-10. This confers a black colour to the soil. In general, the structure of the middle zone shifts from the humus to the parent rock (Chesworth, 2008). In this soil fluorine and arsenic are commonly found in high quantities, which can be transferred to the water. Ferralsol is a good soil for the growth of local vegetation, as coconut palms, but the soil low pH, which combines iron and aluminium oxides, fixes the phosphorus fertiliser, and does not allow the phosphorus plant consumption. The natural vegetation grows thanks to a self-sustaining nutrient cycle, recognised by traditional agricultural practice as shifting agriculture. If the cycle is modified (e.g. deforestation or exportation of agricultural products), the soil loses its fertility and can be subjected to degradation as erosion (European Commission, 2013).

The aquifer is an igneous extrusive rock composed of basalt (MacDonald, 2012; British Geological Survey, 2019). This aquifer type is common in the north of Madagascar. The basalts compose fractured aquifers, usually unconfined, and can support very large springs. The approximated productivity is moderate to high, which means productivity is in the range of 2-20 l/s. The borehole yield depends on the local distribution of fractures, but generally, the maximum yield observed is 7 l/s. Volcanic groundwater is typically low in mineralisation, but occasionally can be brackish to salty. From geological maps of the British Geological Survey (2019), it is possible to collect data for the different aquifer types. Nosy Mitsio is a little island and very often is not represented in the maps. For this reason, information about the aquifer was given by the near Antsiranana area (north of Madagascar), which has the same type of aquifer as Nosy Mitsio. The groundwater storage is about 10-25 m water depth. The estimated depth of the aquifer is 7-25 m b.g.l., and its saturated thickness is about 25-100 m (Sethi and Di Molfetta, 2019).

3. Project evolution during Covid-19 pandemic

In Nosy Mitsio the H4O intervention started in 2017. Before then, the hygienic-sanitary conditions were critical: public services were absent, and 100% of the population was practicing open-defecation (Nyoni and Nyoni, 2020). There was no access to potable water and the local population used to consume untreated water from natural pools and wells. Water was often contaminated by animal carcasses that stumbled trying to reach the water sources. Bevaoko and Ampanitsoha, (400 and 300 inhabitants, respectively) were the two villages selected for the interventions. From the water catchment, the water was conveyed to a water tank and, then, to several taps dislocated within the villages through a pipeline. This has allowed safe and potable water from the springs to the residential yards, the schools, and the Bevaoko's hospital. Two schools with hygienic services were also built in Bevaoko and Ampanitsoha, and the hospital in Bevaoko was upgraded. Water from taps was used by the population to cook, do housework, and as drinking water.

3.1. The "Tany Vao Project"

Tany Vao ("New Land'' in Malagasy) is a people-centred and cross-sectoral project, which aims to improve the living conditions of the inhabitants of Ampanitsoha and Bevaoko. The lack of basic services exposes the Nosy Mitsio inhabitants to health-related risks such as faecal-oral and respiratory diseases mainly due to the absence of WASH infrastructures and the use of indoor open fires. The project, which is a two-year continuation of the Water, Sanitation and Hygiene (WASH) programme initiated in 2018, entails a holistic approach focusing on safe water, toilets and good hygiene, food and nutrition and clean cooking. The project therefore aims to provide access to clean drinking water, improved sanitation facilities and improved cookstoves. However, in order to improve public-health conditions, the project will focus on reducing malnutrition by identifying the criticisms of the local diet and using them to shape the development of climate-smart agricultural practices. Thanks to training and awareness-raising activities, the project promotes community development and empowers the population to be self-sufficient. The direct beneficiaries of the project will be 700 out of 2.500 inhabitants of the island, with a strong focus on children and women.

The project is carried out by H4O in partnership with Kukula and Associazione ELPIS Nave Ospedale. In particular, Kukula is responsible for agricultural and clean cooking activities, while Associazione ELPIS Nave Ospedale undertakes the epidemiological study and medical assistance. Moreover, academic partners will provide technical and scientific support to the project (H4O, 2021; Kukula, 2021).

Within the project framework, the WASH component is the basis for the implementation of further activities. The water supply system will be upgraded by widening the catchment basins and by installing new taps for drinking water. The enhancement of the water supply network will allow for a greater availability of clean water by reducing the length of the round-trip for its collection. Furthermore, a new water supply system will be built to irrigate the vegetable gardens. The irrigation system will maximise water efficiency, reducing water consumption and related environmental impacts.

3.2. Expedition in Nosy Mitsio

At the beginning of December 2020 there was an expedition in Nosy Mitsio by a volunteer of Kukula. The original reason for the expedition was to conduct a census of the local population in Bevaoko and Ampanitsoha, collecting data on age, gender, height, and weight, in order to establish if the population is malnourished and to assess some criteria to select the future beneficiaries of the vegetable gardens.

The expedition also represented the opportunity to collect more information about Nosy Mitsio. The altitude was recorded following the pipeline of the existing water supply system (Figure 3), from the water catchment (WS01) to the village (continuous line).

To supply the gardens with water a source was identified (WS02). The GPS data were taken also from WS02 to the village (dashed line) and around the area where the gardens could be settled. Water samples were also collected in four strategic points in Ampanitsoha where villagers are used to collect water: WS01, WS02, VMM (a pristine well actually not in use) and VMASK (a private well used by a local family). For each point, two samples (0.5 l) were collected, and pH, temperature and Total Dissolved Solids (TDS) were recorded three times to obtain a mean value. Soil samples were also collected taking 0.5 kg of the first 20-30 cm of soil in four points: two in Ampanitsoha (Figure 3: AMP01 and AMP02) and two in Bevaoko.

3.3. Water and soil analysis

Water samples were brought to Antananarivo ensuring the cold-chain and then analysed at the Institute Pasteur de Madagascar: the temperature of conductivity was analysed with a probe, whereas the electrical conductibility and nitrite were analysed following the French standard NF EN 27888 and NF EN 26777, respectively. Chloride, iron, fluorides, calcium, magnesium, potassium, and sulphite were measured with the method of spectroscopy. Hydrogen carbonates were derived through calculations (Table 1). The parameters were compared with well-known threshold values. The only values that overcome the limits are the fluorides at VMM, although for monsoon climate (i.e., high precipitations) the guidelines restrictions are very strict (Ayers and Westcot, 1994). In conclusion, on the basis of the parameters considered, it can be assumed that the water analysed does not fully comply with drinking water standards due to pH and fluoride values, whereas for irrigation use there are no problems (Bortolini *et al.*, 2018). A more complete and accurate assessment requires further analysis taking into account seasonal variability.

Soil samples were brought to Italy and analysed at the DIATI laboratory (Politecnico di Torino). Soil composition was assessed through a granulometric analysis of dry and wet samples (Table 2). For the dry sieve, a mechanical shaker has been used for 10 minutes.

The results of dry and wet sieves are different. If the soil is dry, it can be classified as a sandy soil with a fine material fraction lower than 10%. On the contrary, if the soil is wet, the fine fraction, com-

Fig. 3 – Ampanitsoha village: existing water supply pipe (continuous line) and projected system (dashed line).

Tab. 1 – Results of water sample analysis.

		WS01	WS02	WMM	VMASK
T of conductivity	°C	20.50	20.50	20.70	20.50
EC at 25°C	μS/cm	307	258	599	676
TDS	ppm	180.83	10.38	10.65	10.59
Chloride	meq/l	0.584	0.327	0.623	1.416
Iron (Fe)	mg/l	<0.05	<0.05	<0.05	<0.05
Fluorides (F)	mg/l	1.1	1.0	2.5	1.1
Hydrogen carbonates (in HCO_3^-)	meq/l	2.099	1.400	3.999	3.899
Nitrite	mg/l of NO_2	0.2	0.4	<0.1	<0.1
Arsenic	mg/l	<0.01	<0.01	<0.01	<0.01
Calcium	mel/l of Ca	1.337	0.938	3.833	4.851
Magnesium	meq/l of Mg	0.576	0.004	2.386	0.576
Sulphite	mg/l of SO_3	11.3	8.2	9.5	5
Potassium (K)	mg/l	1.5	3.6	0.2	3.4
pH (mean value)	-	8.86	9.21	8.30	8.09

posed of clay and silt, is over 90%. This happens because the soil has a high amount of fine fraction, which tends to aggregate and form particles with a bigger size. During the wet sieve, thanks to water and the manual mechanical action, the biggest particles disaggregate in the fine fraction. The soil in contact with water shows a muddy texture and becomes very compact due to the high amount of silt and clay. For this reason, it is possible to say that water leaks into the soil for a short time, until the fine fraction absorbs the water, and the soil becomes impermeable. This behaviour explains the great occurrence of mud flow during the rainy season.

4. The struggle with Covid pandemic

The Covid-19 pandemic is the greatest challenge since World War II and the major global health, social, economic and educational crisis of our time. The situation we are living in has proven that modern society is scarcely prepared for sudden negative events. High-income countries are no exception, although economic resources are larger for coping with sudden and unexpected events (Lambert, 2020). Moreover, the pandemic made human beings aware that many personal, social and environmental key aspects were overlooked or taken for granted. For instance, personal basic hygiene practices as well as the relationship between environment and health and the consequences of human actions on nature and environment. This situation highlights the need of reflecting on how the pandemic affects our society through the twelve issues proposed by Shek (2021): "economic development versus saving lives, consumption versus environmental protection, health inequality, economic disadvantage, family well-being, gender inequality, impact on holistic well-being, digital divide, individual rights versus collective rights, international collaboration versus conflict, prevention of negative well-being, and promotion of positive well-being".

Therefore, the time has come to focus on the short and long-term effects of Covid-19 on the environment, health (European Environment Agency, 2020) and each field of work, including international cooperation (Brown and Susskind, 2020). Global uncertainty carried by Covid-19 made a large number of small-scale international cooperation projects in rural areas at risk due to poor NGOs' local structure and the difficulties faced by the remote project management. Covid-19 preventive measures have stopped the displacement from nation to nation for expat staff as well as most of the interactions between the international stakeholders and local beneficiaries. Concerning our case-study, despite the Covid-19 pandemic and all the related difficulties, the Tany Vao feasibility phase has been carried out. It has been possible thanks to the close collaboration between NGOs' we-

Tab. 2 – Passing percentage for wet (W) and dry (D) sieve of four samples 1 (dimension of sieves in mm).

		Sieves						
		0.075	0.106	0.250	0.425	0.85	2.0	4.75
AMP01	Wet	91.80	92.45	95.78	97.46	98.95	99.69	100
	Dry	4.37	5.49	12.32	18.75	35.40	61.60	91.25
AMP02	Wet	86.43	89.37	93.01	94.26	96.21	98.45	100
	Dry	0.59	1.15	5.68	12.13	27.94	53.02	80.21
BVK01	Wet	91.72	92.72	93.85	94.36	95.70	97.40	100
	Dry	1.44	2.13	5.45	9.24	17.45	37.29	73.01
BVK02	Wet	90.25	92.03	94.12	94.95	96.50	97.66	100
	Dry	2.40	3.66	9.24	14.58	25.37	51.29	86.45

Fig. 4 – Photos taken on Nosy Mitsio island. From top left: a local man measures the well depth; the source WS01 at its natural state; locals engaged in the construction of the water catchment at source WS01.

stern staff and local inhabitants and thanks to the in-depth knowledge of local dynamics.

During the feasibility study, the fundamental activities carried out by the local beneficiaries mainly consisted in helping the expat staff member (who went on the field for his first time) during the data collection (Figure 4).

Local inhabitants helped him to identify the natural resources, to assess and perform the data collection and to make him aware of social dynamics within the village. The activities highlighted how local inhabitants have an integrated in-depth knowledge of the natural and social context, which is crucial to carry out the project since its feasibility study. Moreover, local communities have proven the willingness to participate in the Tany Vao project and to make their local know-how open source, for the benefit of the entire community and the environment.

On the other hand, the international staff member brought on the field all the tools and instruments to technically assess the resources, the expertise in using them, and the capability to process the collected data. This phase was also the opportunity for the project to select the key informants within the community and to perform training sessions for the local staff. These activities will be crucial for the locals to be autonomous and to carry out future tasks, only supported from remote.

The success of international cooperation projects is often evaluated based on the achievements of the expected outputs in terms of building facilities or infrastructures, while some other projects are focused on training and awareness-raising activities to be achieved at the end of the project (EuropeAID, 2004). However, Covid-19 highlights the need of carrying out the projects based on the engagement of the direct beneficiaries and local staff. The NGO's expat staff duty turns into supporting local staff from remote, enabling them to carry out most of the project activities. We call this approach "*Smart Cooperation*", which consists in considering and trying to answer the over mentioned twelve issues proposed by Shek (2021) at each phase of the project. The answers often suggest setting a strong collaborative network with local people and to define the role played by each stakeholder, starting from the problem identification and the feasibility study.

With regards to the Tany Vao case study, the *Smart Cooperation* approach is making the project more resilient and participative, mitigating risks of any kind, as is the case of Covid-19 challenge. An effective management and the local inhabitants' engagement allowed the project to keep going and the Smart Cooperation to come true since its feasibility study. Indeed, without this approach it would have been complicated to collect relevant data and information for the project move forward. Based on the Tany Vao case study, the *Smart Cooperation* approach is indispensable to keep the project going and it should definitely be part of the Project Cycle Management for each Cooperation Project.

5. Future vision

The future of Tany Vao, based on the activities carried out during the feasibility study, will definitely follow the Smart Cooperation

Approach. In order to put this approach in place, the local communities will be provided with both the communication devices and the specific training activities for certain project tasks. Nevertheless, some specific activities throughout the whole project will require the supervision and the presence of technical experts on the field to ensure the proper accomplishment of each task.

The first aim of this paper is to enable the scalability and replicability of the projects such as the Tany Vao one. In fact, the goal is to understand the main drivers of the Smart Cooperation Approach success to extend it to other similar contexts. Nosy Mitsio Island, in which the Tany Vao project takes place, has certain peculiar characteristics that shaped the tailor-made design used for the Tany Vao project during its course. That being said, there are some important features in common with many other developing countries all over the world such as geographical isolation, lack of infrastructures, lack of governance, lack of support from public authorities and a number of other aspects that can be found in many other rural and tropical areas. Therefore, we can consider the teachings learned during this study as something applicable in many contexts with similar characteristics in other developing countries.

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