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The effects of climate change on access to water and sanitation on Malolo Island (Fiji): a focus on gender disparities

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Abstract

Access to clean and safe water is a fundamental human right that is essential for the full enjoyment of life and all other human rights, as recognised by the United Nations in 2010[1]. Nevertheless, nearly 5.5 billion people do not have access to a safely managed drinking water service and 4.12 billion people do not have access to safely managed sanitation. This problem is further exacerbated by the effects of climate change, which result in water scarcity due to variable rainfall patterns, higher temperatures, increasingly frequent droughts, saltwater intrusion, and floods. The Pacific Small Island Development States are extremely vulnerable to the impacts of climate change and its related disasters because of their geographic location and characteristics. Among these, Fiji ranks 14th in the World Risk Index, resulting in a high exposure to climate change threats and subsequent reduced water availability. Furthermore, certain groups of the population are disproportionately affected by these impacts, such as low-income households, rural inhabitants, women, and children.

This research studied water availability and access in the Republic of Fiji, particularly in the Island of Malolo (Mamanuca Islands), by analysing how climate change has impacted and is currently affecting water resources in the area. Throughout the research a special focus was placed on the aspect of gender disparities, as this is a cross-cutting topic that is closely linked to water access and climate change. Indeed, women tend to be more affected by water scarcity and the impacts of climate variability due to their domestic roles and societal barriers. In order to perform the research, a first literature review was conducted to provide an overview of the selected country and to assess the status of water resources on the archipelago and more specifically on the island of Malolo. Attention was posed on water statistics regarding drinking, sanitation, and hygiene, as well as water resources management. Subsequently, a brief introduction to basic gender concepts is given to explain how this topic is strictly related to the aspect of climate change, for which a desk review was also conducted. A questionnaire was then developed to conduct interviews in the island of Malolo to villagers residing in Solevu and Yaro to explore their perceptions of water availability and changes in the past years in the island. The questionnaires were asked separately for women and men. The data obtained was then analysed and compared to meteorological databases obtained from the Fiji Meteorological Service. Finally, possible solutions to mitigate the observed effects of climate change in the area are discussed.

[1] Through resolution 64/292, available at https://undocs.org/A/RES/64/292.

Contents

1. Introduction

1.1 Country overview

Figure 1. Map of Fiji. Accessed at: https://geology.com/world/fiji-satellite-image.shtml

The Republic of Fiji is an archipelago situated in Melanesia (Oceania) in the South Pacific Ocean. The archipelago consists of around 300 islands and 540 islets, for a total area of 3,000,000 square km (Fig. 1). Of these islands, only about 100 are inhabited. The largest island is Viti Levu, also named "Great Fiji", where the capital - Suva - is located. Viti Levu has an extent of 10,000 square km, accounting for more than half of Fiji's land area. The second largest island is Vanua Levu, with an area of around 5,540 square km (Foster and Macdonald, 2023).

The islands are based on a submerged platform and their formation is the product of volcanic activity, sedimentary deposit, and formations of coral. The highest point in Fiji is Mount Tomanivi, which reaches a height of 1,324 meters and is located in Viti Levu. The principal river systems - Rewa, Navua, Sigatoka and Ba - are also situated in the main island, with their sources in the central mountain area. Plateaus and lowlands are present in the southeast and southwest, whereas the west, northwest and southeast are characterised by coastal plains (Foster and Macdonald, 2023).

The **climate** in Fiji is warm tropical. Temperatures are moderately stable throughout the year due to the presence of the ocean, ranging from 23-25°C in the dry season from May to October to 26-27°C in the wet season (November-April) (Fig. 2) (World Bank, 2021). Around the coast, night-time temperatures can be as low as 18°C whereas day-time temperatures can reach 32°C (Fiji Meteorological Service, 2006). Temperatures tend to be lower in the elevated inland areas (Foster and Macdonald, 2023). Differences can also be perceived between the leeward and windward side of the mountains: in the former, temperatures can rise to 1-2°C above those on the latter. Besides, humidity is lower on the leeward side (Fiji Meteorological Service, 2006). Regarding precipitation, greater seasonal variation is registered with an average of 250-400 mm per month in the wet season and 80-150 mm in the dry season (Fig. 2) (Foster and Macdonald, 2023). Rainfall is mostly orographic, therefore depending on the topography of the island and on the winds. Fiji's dry and wet season are controlled by the north and south movements of the South Pacific Convergence Zone. Nevertheless, most of its rain falls in heavy short local showers, which are more abundant in the wet season and especially in the larger islands. The SPCZ extends from the Solomon Islands to the east of Cook Islands, and it lies over Fiji in the wet season, whereas it moves a few hundred kilometres north-east and weakens in the dry season. Annual precipitation is spatially variable: for example, in Viti Levu precipitations are much stronger on the east side (3,000-5,000 mm) compared to the west side (2,000 mm) (World Bank, 2021). Furthermore, differences can

occur between the east side and the west side of the islands, such as in the case of Viti Levu where precipitation is stronger on the east side (windward side) (World Bank, 2021). The presence of mountains in the two main islands promote the formation of pronounced dry and wet zones, which are less present in the smaller islands due to their low relief (Fiji Meteorological Service, 2006). Winds over Fiji are generally light or moderate, with the predominance of trade winds from the east to the south-east. Moreover, daytime sea breezes regularly blow across the two main islands (Fiji Meteorological Service, 2006). During El Niño Southern Oscillation (ENSO) events, long droughts can be registered. This event tends to develop around April-June and reaches its maximum strength during December-February. This phenomenon also influences the location and strength of tropical cyclones, which are a major feature of the Fijian climate (Foster and Macdonald, 2023). Cyclones mostly arise between November and April, with the greatest frequency in January and February (Fiji Meteorological Service, 2006). The chance of more and stronger cyclones is additionally influenced by the Madden Julian Oscillation (MJO), an eastward moving pulse of wind and cold which increases moisture and promotes convection. Fiji gets enhanced rainfall when MJO is in phases 6&7, meaning when it is in the Western Pacific. Another phenomenon affecting Fiji's climate is La Niña, which represents the cool phase of ENSO. This event causes increased rainfall and cloudiness in the Western Pacific, as the easterly trade winds get stronger and blow more warm water towards the area. La Niña has severe consequences such as greater frequency of river flooding.

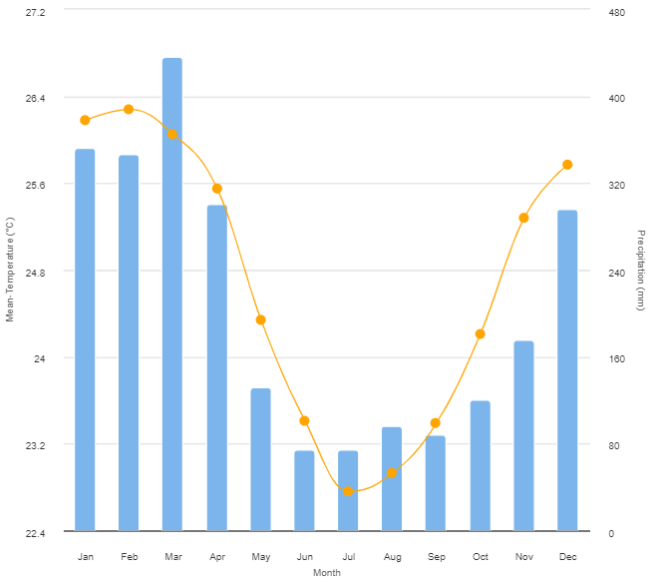

Figure 2. Monthly Climatology of Mean temperature and precipitation of Fiji from 1991-2020. Accessed at: https://climateknowledgeportal.worldbank.org/country/fiji

The Fiji Meteorological Service (FMS) is the department of the Government responsible for providing weather forecast for Fiji. Its aims are to observe and understand the regional weather, climate and hydrological patterns and to provide meteorological and hydrological services.

Most of Fiji's **territory** is forested, with dry grasslands in the western side of the main islands. Many kinds of tropical fruits and vegetables are grown, as well as coconut palms in the coastal areas. The flora comprises hardwood trees, mangroves, bamboo, and palms, whereas the fauna is characterised by bats, skinks, iguanas

and geckos, snakes, and lizards. Natural resources include timber, fish, gold, copper, oil, and hydropower. The shoreline is mainly composed of rocks and reefs, however white-sand beaches can be found. Mangrove swamps are present on the eastern coasts (Country reports, 2023).

The Republic of Fiji has a **population** of 914,126 (Worldometer, 2023), with a population density of 49 per square km. More than half of the population lives in urban areas (52.2%), and the population growth rate is approximately 0.73%. The capital city consists of 177,000 inhabitants (Country reports, 2023). The other two biggest urban centres are situated in Viti Levu as well, namely Nasinu and Lautoka (Foster and Macdonald, 2023). Different ethnic groups can be found in Fiji: although indigenous Fijian people make up more than half the population (51%), there are minorities of Indians (44%), Europeans, Chinese and Polynesians (5%). Therefore, the main languages are English, Fijian – iTaukei- and Fijian Hindi, where Fijian has various dialects. Life expectancy is of 74 years for women and 69 years for men, whereas the median age is 27 for both females and males, making the population very young (Country reports, 2023). In fact, more than one fourth of the population is under the age of 15, and another one fourth is between 15 and 29 (Foster and Macdonald, 2023).

In Fiji, the Gender Inequality Index is quite low and has been decreasing since the 1990s. In 2021, the value was registered to be 0.318 compared to the world average of 0.465, which is based on reproductive health, empowerment and the labour market.

The **economy** of Fiji is mostly based on tourism and agriculture. The percentage of total labour force participation rate (age 15 and older) is 37.7% for females compared to 75.3% for males (Human Development Reports, n.d.).

Table 1 summarises each sector's contribution to the Gross Domestic Product (GDP)[2] of the country.

Sector	**Contribution to GDP (%)**
Tourism	38
Agriculture	8.1
Fisheries	2.8
Forestry	1

Table 1. Contribution of various sectors to the country's GDP, expressed in percentage. Accessed at: https://fijiembassy.jp/profile/economy/sectors-overview/ , https://www.ifc.org/wps/wcm/connect/4fc358f9-5b07-4580-a28c-8d24bfaf9c63/Fiji+COVID-19+Business+Sur and https://www.trade.gov/country-commercial-guides/fiji-agricultural-commodities

[2] GDP: total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period.

Tourism represents one of the main revenue sources in Fiji and supports over 118,000 jobs. Most of the visitors come from the nearest countries, such as New Zealand, Australia, the United States and Japan, while a remarkable number of tourists also come from further countries on cruises, as they are attracted by the landscapes and style which are typical of these Pacific Islands (Foster and Macdonald, 2023).

As previously stated, the country's economy heavily relies on **agriculture** as well, which is dominated by indigenous Fijians. Farmers have created a significant subsistence sector and they earn income by cultivating crops such as copra, cocoa, kava, taro, pineapples, cassava and bananas. Sugarcane is at the basis of the commercial sector, and it is mostly produced by Indian farmers. Sugar production is focused on the western side of Viti Levu; the European Union is the biggest market for Fiji's sugar (Foster and Macdonald, 2023). Women on family-owned sugar cane farms are expected to provide unpaid labour, even though they do not control the income generated thanks to their work (UN Women, 2012). Indeed, women actively participate in most of the aspects of agricultural production such as farming, marketing, food processing and distribution (UN Women, 2012). Landownership in the Republic of Fiji is administered by *mataqali* (clan groups) or through the Native Lands Trust Board. To this regard, women in Fiji are mostly excluded from inheritance rights to land and have land rights permitted by their fathers or husbands (UN Women, 2012).

Furthermore, **fishing** is highly practiced – with fish products accounting for one tenth of the export revenue, as well as boatbuilding, brewing and paint manufacture. In fact, small-scale fisheries provide sources of food and livelihoods especially for rural communities. Indeed, in the Pacific Islands fish provide 50-90% of the animal protein source in rural communities and 40-80% in urban areas. Although women play a fundamental role in this sector, their work is poorly recognised and acknowledged. Women harvest primarily marine invertebrates, for example crustaceans, shellfish and sea cucumbers, and seaweed and they tend to stay close to the shore. Therefore, they are not counted as 'fishers' and their economic and societal contributions are undervalued. Most fisheries policies are 'gender blind' and marginalise women, for example by not providing sufficient funding for women in the sector (Thomas et al, 2021). Women's earning income through fisheries is in fact seen as secondary, after their primary role of providing food for the family and taking care of the home and household members.

In addition, the **timber** industry is relevant and has increasingly developed since the 1960s for domestic use and export. Hydropower is generated in the islands, nevertheless Fiji still strongly relies on fuel, which is imported. Gold, copper, and silver are mined in the islands. Furthermore, another relevant industry is the garment industry which generates high revenues, and the bottling of mineral water for export. Concerning import and export, Fiji relies on the import of products such as machinery, chemicals, and textiles mostly from Singapore, Australia, New Zealand and China. On the other side, the islands export petroleum products, sugar, fish, clothing, water and gold to Australia, the United States and New Zealand (Foster and Macdonald, 2023).

Medical facilities in Fiji are different between urban and rural areas. Considering the former, health-care facilities are adequate for routine medical problems, whereas in rural areas shortages of supplies are often happening and staff training is usually limited. In addition, emergency responses are very limited, and the

availability of ambulances is inadequate with poorly equipped staff. For this reason, medical emergencies are frequently evacuated to Australia, New Zealand, or the United States, where medical care can cost tens of thousands of dollars.

1.1.1 Water access

In 2015, the access to an at least basic water supply according to the WHO/UNICEF Joint monitoring programme was 93.7 for Fiji (WaterAid, 2018).

However, this percentage increased in the last years. The most recent Multiple indicator cluster survey (MICS) report, released in 2022, shows an improvement in access to basic drinking water, sanitation, and hygiene services in the country. Figure 3 shows the results of the 2022 report concerning drinking water, sanitation, and hygiene. The graphs refer to four categories: at least basic, limited, unimproved service and no service[3].

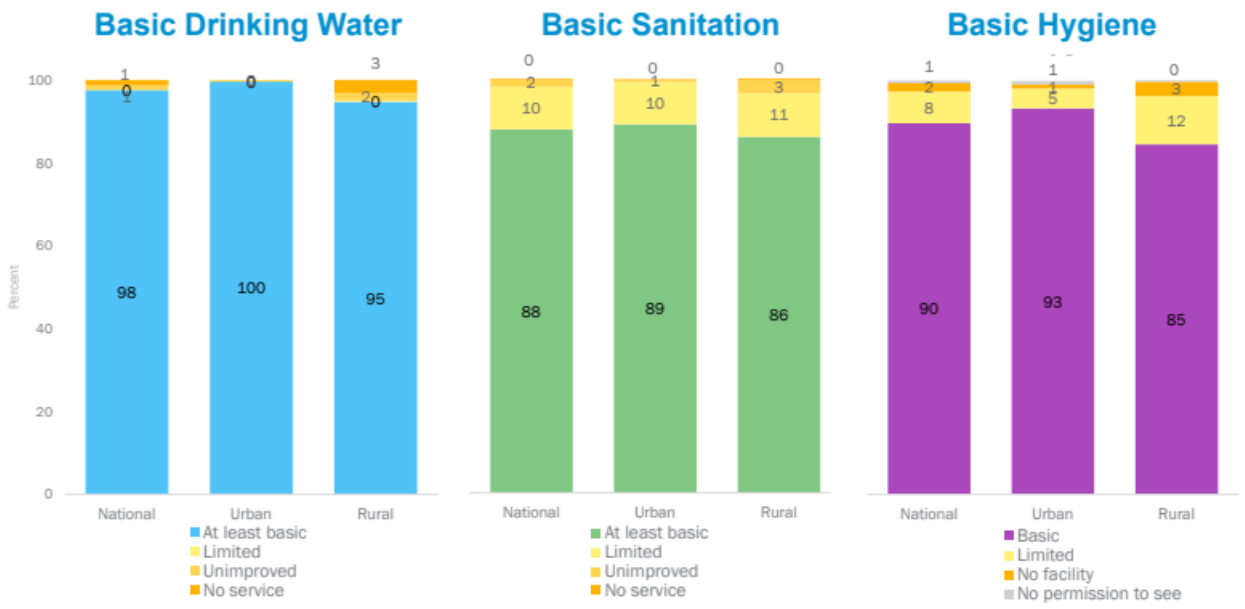

Figure 3. Access to basic drinking water, sanitation and hygiene services in Fiji in 2021. Accessed at: https://mics-surveys-prod.s3.amazonaws.com/MICS6/East%20Asia%20and%20the%20Pacific/Fiji/2021/Snapshots/Fiji%202021%20MICS%20Snapshot%20of%20Key%20Findings_English.pdf

These graphs show promising results, especially concerning basic drinking water, where the percentage of household members using improved sources of drinking water is 97.7, where 97.6% use improved water sources either in their dwelling or yard or within 30 minutes round trip to collect. 54.0% of household members have a water source available when needed, but only 30.9% have an improved drinking water source on

[3] For drinking water, at least basic means that an improved source is present at no more than 30 minutes for a roundtrip; limited refers to an improved source at more than 30 minutes roundtrip; unimproved includes unprotected water sources and no service refers to the drinking of water from surface water. As for sanitation, at least basic means that sanitation facilities are not shared with other households; limited refers to improved facilities shared with other households; unimproved sanitation facilities include for example pour flush to an open drain and bucket latrines and no service is referred to open defecation. Finally, in the hygiene category basic refers to the availability of handwashing facilities with soap and water; limited refers to facilities lacking soap and water and no facility means there is no handwashing facility in the household.

premises which was tested and free from *E.Coli* and available when needed. The report also reveals that 98% of the household members use improved sanitation facilities and 87.7% use sanitation facilities which are not shared. Regarding the removal and safe disposal of excreta, 87.2% of household members live in households with improved on-site sanitation facilities from which waste has never been emptied or has been emptied and buried in a covered pit. 8.7% use an improved on-site sanitation facility from which a service provider has removed waste for treatment off-site. Lastly, 23.1% of the women aged 15-49 reported menstruating in the previous 12 months and not participating in social activities, school or work due to menstruation since they lacked access to adequate menstrual hygiene management facilities and supplies and experience stigma. (Fiji Bureau of statistics, 2022a). Indeed, there is a lack of information regarding menstrual hygiene management (MHM); therefore, research was conducted by UNICEF to understand the challenges faced by girls at school. For example the inability to manage menstruation at school due to the inconsistent availability of materials such as water, soap, toilet paper and sanitary pads was reported. This was identified to be compounded by cyclones and floods. For instance, cyclones negatively impacted girls' privacy by damaging toilet doors or as a consequence of the cyclone the toilets had to be relocated to a place where girls did not feel safe going alone (Francois et al, 2017).

A perceivable difference can also be highlighted between rural and urban household members. Indeed, the percentages of access to basic drinking water, sanitation and hygiene are lower when referring to rural areas compared to urban centres, especially in the case of hygiene. Other differences in the background characteristics of the members can be spotted, such as wealth, division, and education of household. To this regard, access to basic water is slightly lower in the Eastern division and among people living in the poorest households[4].

The Water Authority of Fiji is one of the main stakeholders in the WASH sector of Fiji. Indeed, it is the water and wastewater management service provider. WAF is a Commercial Statutory Authority established by the Fijian Government and it provides access to quality drinking water and wastewater services to over 154,000 residential and non-residential metered customers in urban and rural areas. The network comprises more than 4932 kilometres of pipes which supply more than 134,000 megalitres of treated water annually, covering 18,274 square kilometres of the islands of the archipelago.

1.1.2 Challenges

There are various challenges facing Fiji's water. The main ones can be hereby summarised:

1. **Economically unviable water utility**

[4] https://mics-surveys-prod.s3.amazonaws.com/MICS6/East%20Asia%20and%20the%20Pacific/Fiji/2021/Snapshots/Fiji%202021%20MICS%20Snapshot%20of%20Key%20Findings_English.pdf

Fiji has a current tariff rate for domestic and commercial customers which is the cheapest in all the Pacific region. As a consequence, the Water Authority of Fiji (WAF) has only been able to meet 50% of its operational costs in the past six years. Therefore, WAF has to rely on government funding for operational and capital expenses. Besides the low tariff cost, the Water Authority of Fiji also provides free water to households that have an income of less than $30,000 thanks to a free water allowance scheme (WAF, 2023).

2. **Climate change and environmental impact**

   Fiji is particularly vulnerable to climate change being a small island state. The major risks that the country will face are, for example, sea-level rise, ocean acidification, damage to marine ecosystem, prolonged drought periods, increased flooding. These events will result in low water levels and disruption in the provision of water and wastewater services (WAF, 2023).

3. **Ageing infrastructure and skills and capability gap**

   In Fiji, most of the infrastructure and assets are close to the end of their design life; nevertheless, they keep being used to satisfy the demand of the growing population. This results in breakdowns of water supply and services, in addition to costly operations. For example, in Greater Suva Area there are two main water treatment plants which were built in 1961 and 1982, therefore being more than 40 years old. Since the plants were built population has tripled, and the plants are operating at 110%; however, there is still a daily shortage of 3 million litres between supply and demand. Pipe bursts and leakages cost WAF $23 million annually, and 50% of the water treated is lost while travelling to reach customers across the pipe network. Indeed, there is urgent need to invest in asset renewal.

   Besides, workforce skills and competency gaps are present and need to be addressed as they impact the water sector operations (WAF, 2023).

1.1.3 Basic concepts on gender[5]

Water access and use are intrinsically tied to gender roles and responsibilities.

Therefore, it is fundamental to distinguish between the concepts of ‘sex’ and ‘gender’. First of all, sex is described as the biological differences between men and women. On the other hand, gender refers to the relationship between men and women and how this is socially constructed. The latter is influenced by economy, religion, culture and traditional values. Generally, gender stereotypes are created by having generalised views or preconceptions about characteristics that should be possessed by women or men and their roles. In many cases, stereotypes about the role of women within the household and family lead to unequal division of labour, resulting in time poverty for women and lower levels of education.

In addition, another relevant distinction must be considered between gender equity and gender equality. Gender equity means being fair to men and women, taking into account their different needs and power due to women’s

[5] Adapted from UNESCO WWAP Capacity Development Programme

historical and social disadvantage. Gender equality, instead, refers to equal rights, responsibilities and opportunities for women and men. Gender equity is fundamental to reach gender equality.

Hence, gender equity can be combined with gender empowerment - for both women and men - and gender mainstreaming to pursue gender equality. More specifically, gender empowerment refers to people taking control over their own lives, gaining skills, and developing self-reliance. Instead, "mainstreaming a gender perspective is the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in all areas and at all levels. It is a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally, and inequality is not perpetuated"[6]. Gender mainstreaming can happen through publications, media, projects, education and policies.

In order to incorporate gender into programmes and policies, gender analyses are needed. A gender analysis is the collection and analysis of sex-disaggregated information, exploring the differences between women and men related to their various experiences, knowledge, talents and needs and reflect these differences in policies and programmes. The first step of this process is, therefore, the collection of sex-disaggregated data, followed by a statistical analysis of the data which can lead to evidence-based policy making (Fig. 5).

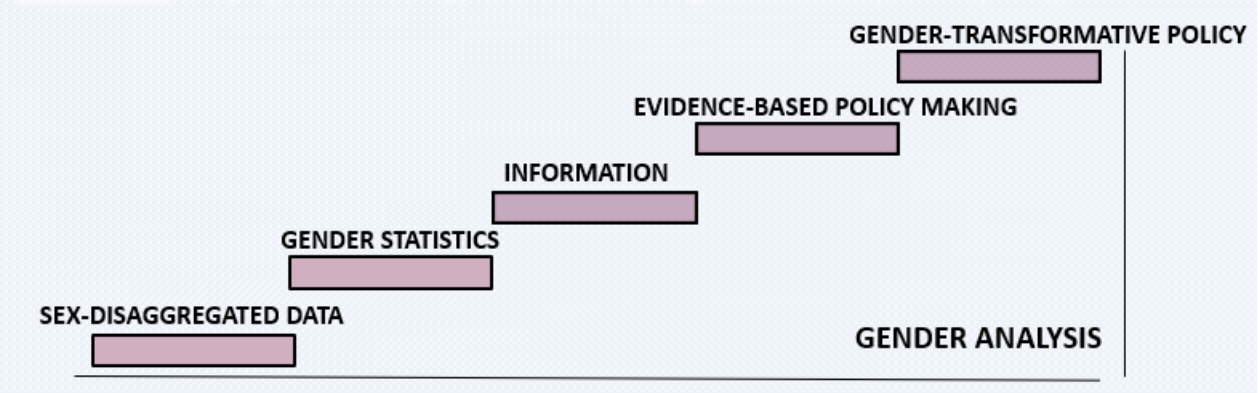

Figure 3. The process of gender analysis. Accessed from UNESCO WWAP Capacity Development Programme

The Government of Fiji has made various commitments to gender equality, both at the international and regional level.

The former includes, for example, UN conventions and agreements in support of the implementation of the Beijing Platform for Action. These international agreements set the standards and norms that a country must aim at achieving, by providing guidelines for strategic planning, policy making, monitoring and evaluation. Table 2 provides a list of the gender-related international conventions signed or ratified by Fiji (ADB, 2015).

[6] Economic and Social Council. Coordination of Policies and Activities of the Specialized Agencies and Other Bodies of the United Nations System Related to the Following Theme: Mainstreaming the Gender Perspective into all Policy and Programmes in the United Nations System. ECOSOCAC/1997/2, New York: United Nations, 1997

Commitment	Ratification/signing date
Convention on the Elimination of All Forms of Discrimination against Women (CEDAW)	1995
Convention on the Rights of the Child	1993
Convention on the Rights of Persons with Disabilities	2010
International Labour Organisation (ILO) Equal Remuneration Convention (No.100)	2002
International Labour Organisation (ILO) Discrimination in Employment and Occupation Convention (No. 111)	2002
Pacific Leaders Declaration on Gender Equality	2012
Pacific Leaders Declaration on Sexual and Gender Based Violence	2010
Regional Action Plan on Women, Peace and Security	2012
Revised Pacific Platform for Action on the Advancement of Women and Gender Equality 2005–2015	2004

Table 2. International Conventions with gender dimensions. Adapted from: https://www.adb.org/sites/default/files/institutional-document/210826/fiji-cga-2015.pdf and https://weareaptn.org/wp-content/uploads/2022/04/APTN-Legal-Gender-Recognition-in-Fiji-D5-LowRes.pdf

Moreover, other legislations and policies in support of gender equality exist at the regional and national scale, such as the **Constitution of Fiji**, signed into law in September 2013; the **Human Rights and Anti-Discrimination Commission (HRADC)** issued in 2009; the **Roadmap for Democracy and Sustainable Socio-Economic Development 2010–2014; t**he **National Gender Policy (2014)**, which is the main national policy on gender equity, equality, social justice, and sustainable development (ADB, 2015); the **Climate Change Act** of 2021, which aims at promoting gender equality and women's human rights and empowerment while addressing climate change, and at considering inclusive processes in regard to displacement; the **Gender Equity & Social Inclusion Policy 2021-2024** implemented by the Ministry of Economy (MoE) and the

Government of Fiji (GoF) and finally the implementation of the Fiji **National Climate Change Policy 2018-2030** (NCCP) by the Ministry of Economy.

1.1.4 Description of area of interest

The Mamanuca Islands

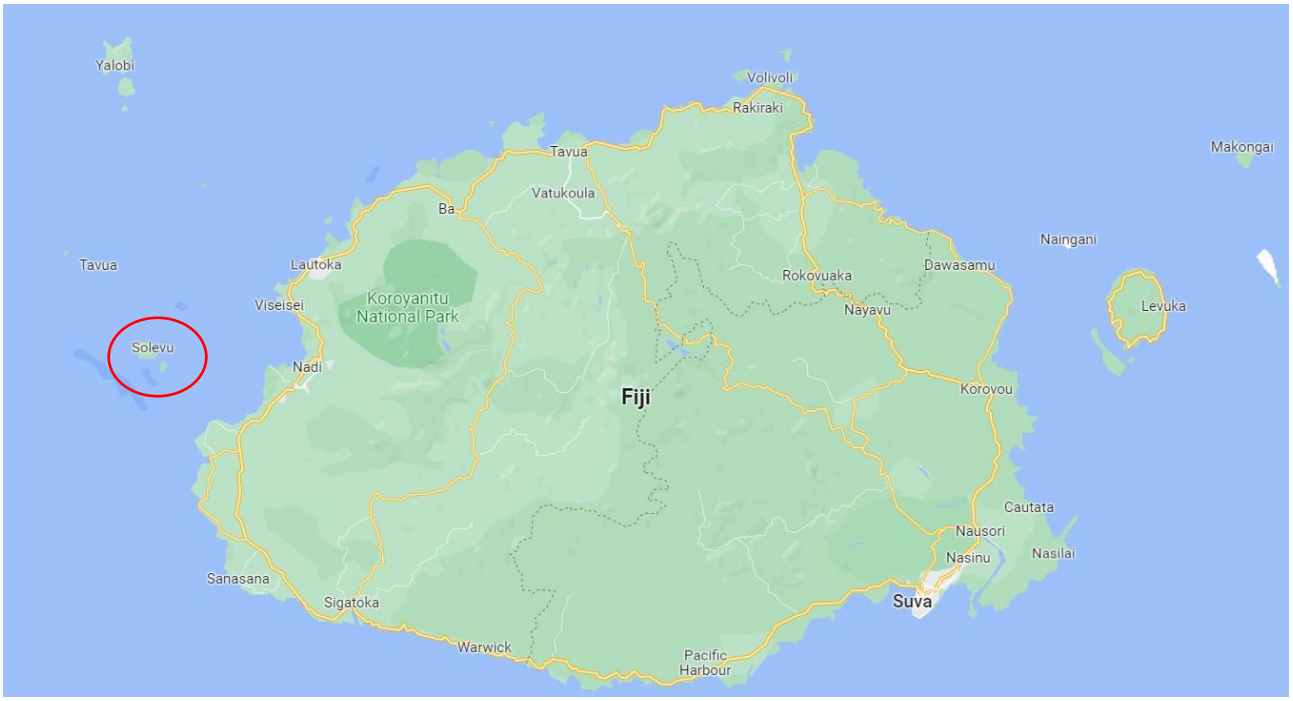

Figure 6. The Mamanuca Islands, Fiji. Source: Google Maps

The Mamanuca Islands are an archipelago of volcanic origin, located west of the main island of Viti Levu opposite to Nadi (Fig. 6). From an administrative point of view, they are part of the Western Division and in particular the province of Nadroga-Navosa. The group of islands consists of about 20 islands, not all of which are inhabited: in fact, seven of these are covered by the Pacific Ocean at high tide.

Malolo Island

Malolo is the largest island of the Mamanuca Islands, measuring 2.4 square kilometres (Fig. 7). As it is part of the Mamanuca Islands, it is of volcanic origin. It is inhabited and hosts two villages, Solevu and Yaro.

In 1840, members of the United States Exploring Expedition under Charles Wilkes arrived in Malolo to survey the island. During their visit, two members of the crew were killed by natives while they were attempting to negotiate for food. In retaliation, more than 80 men from the expedition crew attacked and

Figure 7. Malolo Island. Source: Google Maps

destroyed the villages in Malolo, killing 87 natives and damaging all the crops.

The island is densely vegetated with trees such as palm, mango, papaya, breadfruit and banana. The vegetation covers most of the island but tends to dry out during the dry months, as little or no rain is received. There are no rivers on the island, nevertheless groundwater is highly available. Malolo is characterised by steep hills, especially in the central area of the island. A coral reef is present in the southern part of the island.

The economy of Malolo is based on tourism, as the island is home to five resorts. The villagers of Solevu and Yaro generally work in the resorts as cleaners, housekeepers, plumbers, or security guards. Therefore, the resorts are their main source of income. In addition, in order to use the land, the resorts have to pay a lease to the villagers. Some inhabitants of the villages– mostly men- also practice fishing and sell their fish to the resorts; on the other hand, women catch and sell crabs, as well as selling handicraft and shells in local markets to tourists from the resort. An additional source of income is the transportation service provided by the villagers, who accompany tourists around the island with their own fibre boats.

On the island there is only one school, located in the village of Solevu. Students can reach secondary education there, and then have to move to the mainland to pursue tertiary education. All classes are taught in English by teachers who mostly come from the mainland.

The two villages of Solevu and Yaro have a population of respectively 500 and 360 inhabitants. Inside the villages there is an organised structure composed of a village chief, a headman, and a nurse, who collects statistics about the inhabitants. The villagers' food supply consists of fish, root crops such as cassava and yam, and tropical fruits. Vegetables are not present due to the quality of the soil, which is siliceous, therefore people tend to buy them from the mainland. The men usually go to the farms during the day, while the women stay at home or work at the resorts. Typical animals present on the island are cows (mostly used for meat production), chicken and pigs. Electricity is generated through solar panels, which are provided by the government, and by small generators. Between the two villages there is only one medical centre, which disposes of a doctor and a nurse.

The inhabitants of the island mostly rely on rainwater and groundwater. The former is consumed for drinking, whereas the latter is generally used for cooking, cleaning, bathing, and for the toilets. Most of the rainwater is collected in tanks during the wet season, while the dry season causes serious issues of water scarcity, which is exacerbated by climate change. Contrarily, the many resorts on the island source water from the sea and use sophisticated and costly desalination plants, which enable a steady supply of water for the resorts and the staff.

1.2 Research project

Surface water is a crucial resource on which the majority of Fiji's population (70%) and industry rely on, with the very frequent use of rainwater harvesting (World Bank Group, 2021). In fact, in 2017, 70% of the households had access to piped drinking water whereas the remaining 30% relied on groundwater sources such as boreholes, wells and spring water (Sanitation and Water for all, 2021). These resources are extremely vulnerable to changes in climate intensity and frequency of events. Therefore, the uncertainty in future

projections for climate are a challenge for planning and monitoring. Hence, it is fundamental to increase the storage capacity for periods of water scarcity, to improve the robustness to storm damage and extreme rainfall events and to build stronger systems in order to deal with water quality issues and pollution. The Government of Fiji has recognised the water infrastructure to be at particular risk to soil erosion and landslides during extreme events; furthermore, more than 20% of water resource assets lack waterproofing and are exposed to flooding. The latter is also caused by human activities, such as alterations to upstream catchment areas, for example deforestation. Moreover, some communities who live in the outer islands of Fiji are highly dependent on groundwater resources and coastal aquifers, which are however vulnerable to saltwater intrusion and over-exploitation. (World Bank Group, 2021). Moreover, all of the Pacific Island countries are severely affected and exposed to tropical cyclones, storms, inundation, volcanic activity, earthquakes and floods. These events are increasingly compounded by climate change, with prolonged social consequences. The World Risk Index (WRI) ranks the world's countries based on an assessment of their exposure and vulnerability, where the latter is defined by the susceptibility of the likelihood of harm from the event; the capacity of communities to minimise the impact; and the availability of resources to make adaptations and strategies to mitigate future events. According to this index, in 2021 Fiji ranked 14th out of 181 countries assessed (Wilson et al, 2022).

This research and the relative data collection were performed in the framework of the project "Accelerating Sanitation for All in Asia and the Pacific", more specifically "Water and Climate Change: Women's coping strategies in Pacific Small Island States" led by UNESCO World Water Assessment Programme and the Asian Development Bank (ADB), with the aim of observing and understanding the effects that climate change has on access to clean water and sanitation in the Republic of Fiji, particularly on the island of Malolo in the Mamanuca Islands. Gender disparities are also taken into account, as a cross-cutting topic closely linked to water, sanitation and hygiene (WASH) and the impacts of climate variability.

To do so, the situation of water, sanitation and hygiene in Fiji was assessed through literature research, which was also used to produce the first draft of a questionnaire for a survey to be used in the field. In fact, field work was conducted in Fiji, specifically in the island of Malolo, where face-to-face interviews were performed to villagers by conducting the previously prepared survey. The latter was finalised with the help of technicians and scientific officers from the Water Authority of Fiji and from the Fiji Meteorological Office. The main topics of the survey included WASH, climate change, governance and education. Subsequently, analyses were performed on the data obtained on the field, after systematising it. Moreover, as the perceptions of climate change were asked to the interviewees, these were compared to meteorological data from the past 30 years in Fiji (obtained through FMS). Limits and possible future upscaling of the project are finally discussed, after proposing potential solutions for the villagers to cope with climate change.

2. Materials and methods

2.1 Workshop in Nadi, Fiji

This research project included the preparation and delivery of a 2-day face-to-face workshop in the premises of the Fiji Meteorological Service in Nadi, Fiji, the 10th and 11th of July 2023 (See Annex I). The workshop was conducted together with Ms Laura Imburgia, Senior Water and Gender Programme Specialist from UNESCO World Water Assessment Programme and delivered to 8 participants from the Fiji Meteorological Service (FMS) and the Water Authority of Fiji (WAF) (Fig.8):

Figure 8. Fiji Meteorological Office, Nadi.

- Varanisese Vuniyayawa – Senior Technical Officer, Climate Division, FMS
- Ilaijia, Nalale, Technical Officer, Climate Division, FMS
- Apete Delaiverata, Technical Officer, Climate Division, FMS
- Josevata Lomani, Technical Assistant, FMS
- Jasneel Chandra, Scientific Officer, Climate Division, FMS
- Shweta Shiwangni, Scientific Officer, Climate Division, FMS
- Winnie Hoyte, CEOW, WAF
- Isikeli Naivakadula, Technical Officer, WAF

Slideshow presentations were prepared to assess and explain the following topics throughout the workshop:

- Water and gender concepts and frameworks
    - Gender basic concepts
    - Water and gender
- Sex-disaggregated water data and gender indicators
- The WWAP 'Water and gender' Toolkit
- The WWAP gender-responsive indicators
- Guidance for water and gender data surveys
- Water and gender data entry and analysis
- From information to policy
- Water, climate and gender

These were addressed in two days, in which theory was merged with interactive activities such as group discussions.

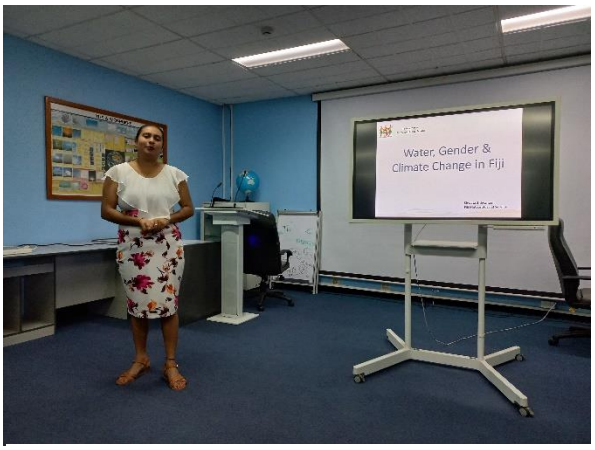

Figure 9. Ms Shweta Shiwangni, Scientific Officer of the Climate Division at FMS.

A presentation was also held by Ms Shweta Shiwangni (Fig.9) on Water, Gender and Climate change in Fiji. Her discussion focused on the drivers of Fiji's climate and variability from a scientific perspective, which include orographic rainfall, the South Pacific Convergence Zone, the Madden Julian Oscillation, El Niño and La Niña. Furthermore, Ms Shiwangni presented the climatic trends of Fiji together with future climate projections of rainfall, temperature, sea level rise, and cyclones. Finally, the topic of water problems in Fiji was addressed, with a focus on gender disparities in the water sector and more broadly in the Fijian society.

Another important part of the training included group discussions to prepare and redefine the survey to be used during the fieldwork, as to tailor it to the issues of the field site based on the extensive knowledge of the members from WAF and FMS (Fig. 10). The survey included questions on various topics, starting from the general information of the interviewee and their family, to continue with a series of questions on water access and use and the relative issues. Furthermore, sanitation and hygiene were explored, to then ask more specific questions on climate change and the interviewees' perceptions of it. Finally, a section was dedicated to governance – such as the participation to village committees- and another one to education and trainings (See Annex II). The participants provided feedback on the questions, length, and clarity of the survey, and added relevant inputs considering their experience and background.

Figure 10. Participants of the training held at FMS in Nadi.

The diversity of the attendees' background, being technical officers, scientific officers and technical assistants working both at the Fiji Meteorological Service and the Water Authority of Fiji strongly contributed to the research, by making the survey accessible to a wider variety of people.

Moreover, the presentations that were delivered encouraged both FMS and WAF to try to include gender policies in their work area in the future, for example by organising more trainings and awareness raising on similar topics.

2.2 Field work on Malolo Island

Figure 11. Island of Malolo, Mamanuca Islands.

The data collection took place in Malolo Island (Fig.11) from the 12th to the 16th of July 2023. The island is part of the Mamanuca Islands, in the western division of Fiji. Three participants from the training attended the field work in Malolo: Ms Shweta Shiwangni, Ms Winnie Hoyte and Mr Isikeli Naivakadula.

Upon arrival on the island, the team had a brief visit of the village and then organised a meeting with the head of the village to explain the purpose of the mission and the activities of the following days. The head of the village also provided information regarding the village, its structure (location of houses, of the main boreholes, of the school and of the medical centre) and inhabitants. During the welcoming celebration, a first interview was conducted to test the survey, which was then adjusted accordingly to the level of English of the villagers and their general knowledge of the topics covered. Moreover, an informal interview was done to the 'village nurse', the woman in charge of collecting population statistics and make health arrangements.

The survey was then implemented by the team in the following two days, to obtain a total of 40 interviews. Each interview lasted around 25 to 40 minutes – depending on the amount of information given by the interviewee- and they were conducted in two villages of Malolo, respectively Solevu and Yaro. A note of consent was verbally agreed by each interviewee to accept the conditions of the survey: the participants were informed about the purpose of the survey and the future use of the data collected. It was also specified that the survey was anonymous and could be stopped at any moment.

The first day was centred on interviewing villagers from Solevu (Fig.12 A,B). Three teams of two people were created, coupling team members from WWAP and WAF and from FMS and the village headman, in order to compose teams able to speak both English and Fijian and to put together various strengths and points of view of the team members. Based on the information obtained from the headman of the village regarding the location of the main boreholes and pipelines, the village was divided by the team in three areas. Each area was assigned to one of the teams to cover, as to obtain varied information related to the different problems that villagers living in distinct areas of the village have. One team covered the houses that were far from the village centre, another team interviewed the housed in the centre and the last team conducted the surveys in the upper part of the village. Interviews were therefore conducted by going from house to house, and it was decided by the team members to interview one house and skip the two following ones. Some interviews were done inside the interviewees' house whereas others were conducted outside, under shelters built by the villagers. A few surveys were done to villagers who spontaneously asked to be interviewed by seeing the work performed by the team members to other villagers. Oral consent was always obtained from the interviewees before interviewing them. 21 interviews were conducted that day.

The next day the team members moved by boat to the nearby village of Yaro (Fig.12 C). Upon arrival in the village, the team members were introduced to the headman of that village and the purpose of the trip was explained. After agreeing on the conduction of the interviews, the structure of the village was observed and as it was done for the previous village the team members were divided in three groups. Each group interviewed a different part of the village. The interviews included the village nurse, the village headman and a member of the water committee. The same strategy as for Solevu village was applied, however less interviews were performed as many of the houses were empty, since the villagers were either at work or attending a funeral in the close by village of Yanuya.

Figure 12. Arianna Fusi, Junior Consultant at the World Water Assessment Programme, conducting interviews in the villages of Solevu (A,B) and Yaro (C).

The last day of mission was spent conducting in-depth debriefing among the team members, where the main results of the interviews were explained, and relevant observations were shared to compare ideas and inputs from different points of view. A possible upscaling of the field work was discussed.

2.3 Data analysis

Once the surveys were conducted, the information gathered was systematised and digitalised by transferring it into a spreadsheet. A code was assigned to the various answers: for example, the 'yes/no' answers were given

the code 1 for ‘yes’ and 2 for ‘no’. On the other hand, open questions were synthetised into key words to group and filter them.

After synthetising the data, basic analyses were first of all performed. Pivot tables were plotted to cross the data from the two different villages and compare it, in addition to tables showing the total data. Sex-disaggregated tables were also created to observe the different situation of women and men with relation to water, sanitation and climate change. Most of the tables were made by using the function ‘count’ of the pivot table; subsequently, graphs such as clustered columns, stacked columns, clustered bars and pie charts were produced starting from the database.

Moreover, data regarding maximum and minimum temperatures, rainfall, cyclone activity, droughts, floods and sea level in the past 30 years (or more, when available) was provided by the Fiji Meteorological Office. The data on temperature and rainfall was taken from the “CliDE” (Climate Data for the Environment) database, which was produced as part of the Pacific Climate Change Science Program (PCCSP) and developed under the Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP). The scope of this database is to provide database capacity for PCCSP/PACCSAP partner countries to store meteorological observations in a robust climate data management system. All meteorological data are stored as System International units. As the island of Malolo does not dispose of a weather station, the data was obtained from the Nadi Airport station, which represents the closest weather station to the island. On the other hand, regarding the other variables, data was extracted from PDF documents which recorded on cyclones, droughts, and floods in Fiji. Finally, data on sea level was obtained by downloading it from the Australian Government-Bureau of Meteorology website. The data in these documents was systematised by transferring it on excel. The period in which the different variables were recorded varies in years, as it is shown in table 3:

Variable	**Period**
Maximum temperature	1990-2023
Minimum temperature	1990-2023
Rainfall	1990-2023
Droughts	1965-2020
Tropical cyclones	1969-2022
Floods	1840-2009
Sea level	1992-2023

Table 3. Periods of collection of data on the different variables obtained by FMS.

This data was used to compare the perceptions of the villagers regarding climate change with the actual changes that have been registered by FMS concerning the aforementioned variables. First of all, the excel files were transformed in CSV format in order to import them on the R Studio Software. Subsequently, analyses were performed for each variable. Regarding the maximum and minimum temperature, rainfall and sea level the data was monthly: therefore, after reshaping the tables in the correct form, time series were created and plotted. On these, the seasonality was then removed to make the time series constant and observe their trend, for which the trend line was plotted. For the remaining variables, the data was yearly; in fact, the annual values were plotted in bar plots and the trend line was observed. Once the trend was evident for each variable, these graphs were compared to the graphs that were previously obtained on the perceptions of the interviewees. Seven histogram charts were in fact plotted on excel - one for each variable - with three conditions: increase, decrease and no change. These refer to the perception of the villagers who were interviewed and were asked if they have perceived one of these options concerning the variables in table 3 in the past 30 years approximately. The comparison made it possible to observe the accuracy of the perceptions of the interviewees with respect to the actual weather conditions and to observe their awareness on climate change.

In addition, OLS regressions were performed on R Studio to see the possible correlation between socio-demographic variables - such as age, sex, and household type - and the perceptions of change in the studied variables, namely temperature, rainfall, droughts, tropical cyclones, floods and sea level.

3. Results

The following results are the output of the analyses performed on the data obtained from the survey conducted through face-to-face interviews in the island of Malolo, in the Mamanuca Islands, more specifically in the villages of Solevu and Yaro. The survey questionnaire can be found in annex X.

Among the two villages, 40 people were interviewed (65% women and 35% men, figure 13)

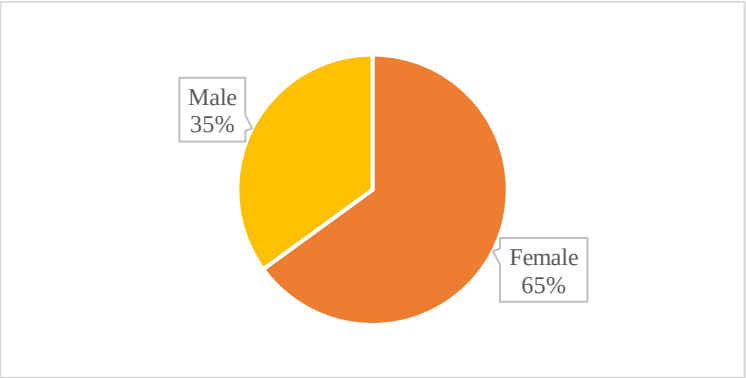

Figure 43. Gender of the interviewees in Malolo Island. N=40.

The age of the interviewees was well distributed, as reported in figure 14:

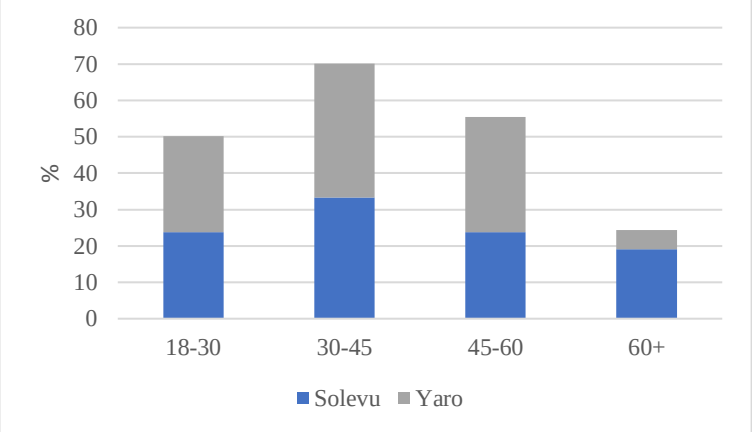

Figure 14. Age of the interviewees in Solevu and Yaro.

3.1 General information on Solevu

The village of Solevu is the biggest of the two and it has 117 houses with reported 500 people. There are 275 females and 225 males, and the oldest inhabitant is 88[7].

Solevu disposes of a school and a medical centre.

The school is primary and secondary, with the secondary school being a boarding school where children from all the group of the Mamanuca islands come. All the classes are taught in English.

[7] Source: personal communication with the village nurse

The medical centre has 3 quarters, its doctors come from the mainland even though they are permanent. In the villages there are no registered waterborne diseases nor dengue, but there are many non-communicable diseases (NCD), such as diabetes and high blood pressure. According to some respondents, diabetes is caused by the high amount of sugar present in root crops, especially cassava, and by the high consumption of sugary drinks - such as coke - and junk food. As the village nurse stated, due to diabetes many people have to amputate their legs at 40-45 years old; moreover, they suffer from heart attacks caused by the blood pressure at around 35. The nurse also said that women are likely to suffer from heavy menstruation and cervical cancer. Regarding the former, respondents indicated that girls continue to attend school during their menstruation period; however, the toilets do not dispose of sanitary bins, so they need to take their pads home. The village nurse also stated that the government provides the girls with 2 packets of pads a month, and they use cloths when the pads are finished. Baby delivery is done on the mainland, in fact respondents indicated that pregnant women move there 2-3 months before the delivery, and they are usually hosted by relatives in Nadi or Lautoka. Some villagers indicated that they are not vaccinated for covid due to religious reasons.

The main types of food reported are fish, yam, cassava and sweet potatoes. Farming is difficult in the island due to inappropriate soil types. Therefore, the villagers buy the vegetables from the mainland. Some villagers reported to have cows, pigs and chicken for their own consumption[8].

From the survey respondents in Solevu, most stated being unemployed (57%), whereas only 14% are employed – for example working at the resorts- and 19% are self-employed – meaning that they sell handicrafts, or they have their own business, for instance selling kava[9] and beans (Fig.15).

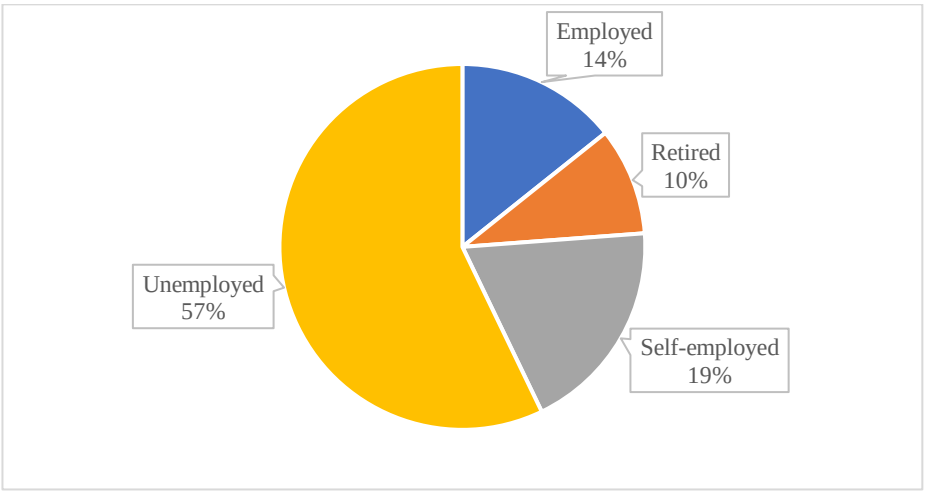

Figure 15. Percentage of interviewees who are employed, self-employed, unemployed or retired in Solevu.

As it is shown in figure 16, the main sources of income reported by the interviewed villagers was, in descending order: part time jobs and relying on a relative's salary; full time jobs; having a business and receiving remittances (for instance by the resorts).

[8] For example Sol_a_02 and Sol_a_04
[9] Traditional national drink of Fiji, made from a crushed root.

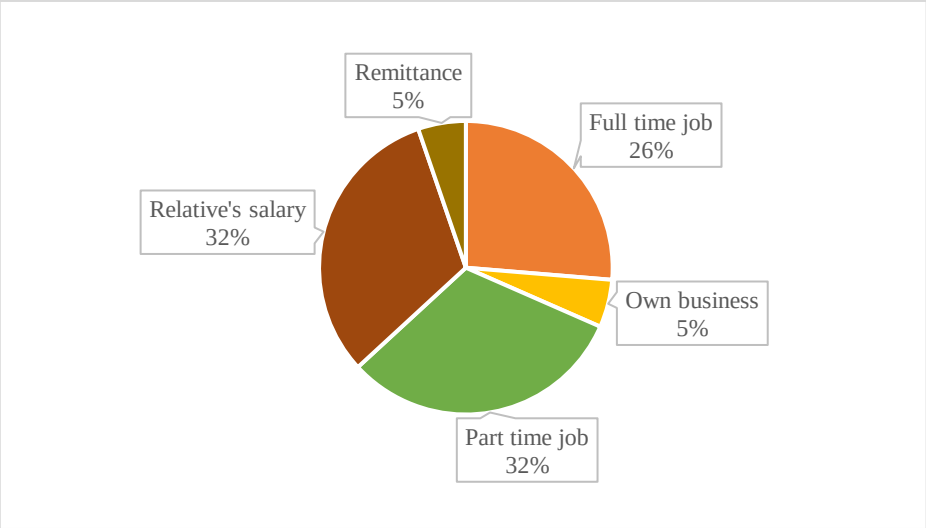

Figure 16. Main sources of income in the village of Solevu.

Of the 40 interviewees, the majority was married (62%). Only 10% of the interviewees were single, and 19% were widowed. No divorced couples were registered (Fig. 17).

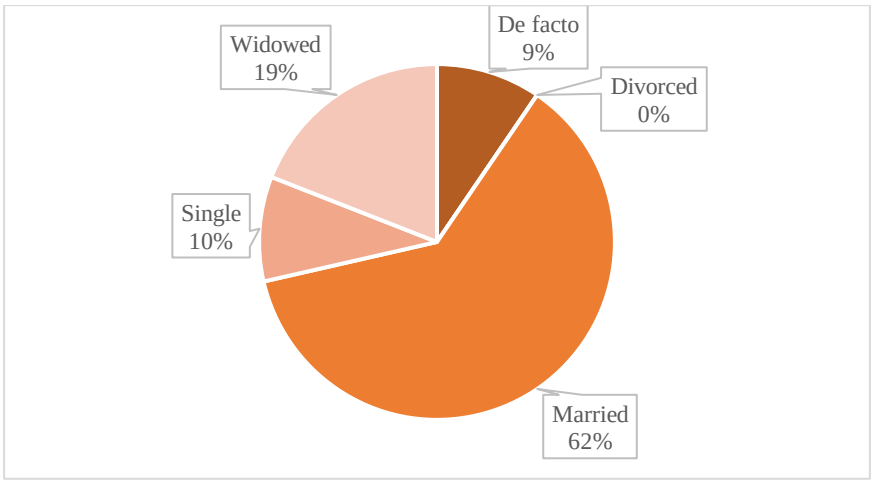

Figure 17. Percentage of interviewees who are married, de facto, single, divorced or widowed.

Notwithstanding the strong majority of women interviewed, 81% of the households interviewed stated being male headed, compared to only 14% which were female headed. 5% of the households reported having both a woman and a man as head (Fig. 18).

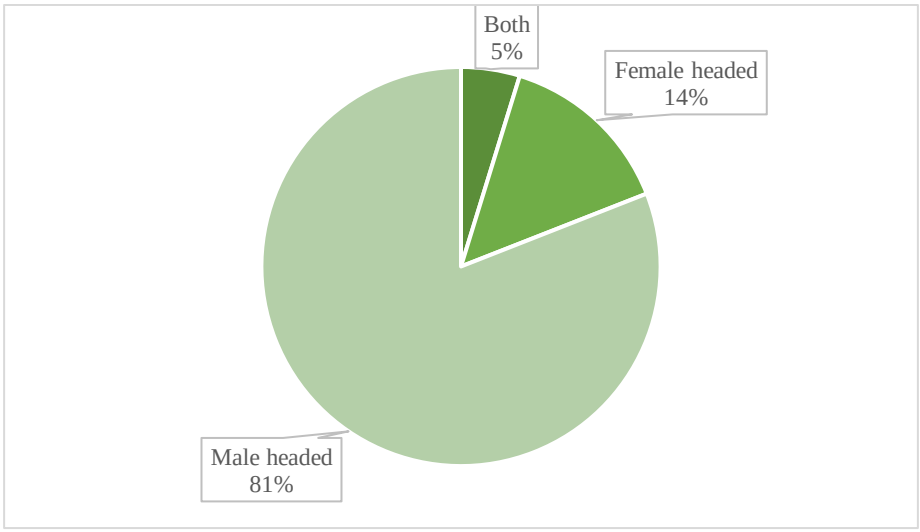

Figure 18. Type of household in Solevu.

3.2 General information on Yaro

In Yaro the statistics available on the village dated back to 2020, when there were 60 households with 365 people, of which 180 were women and 185 were male.

The village disposes of the same hierarchical structure as Solevu, with a village headman and a nurse dealing with the village statistics.

There is no medical centre, as the one in Solevu is used for both villages.

Moreover, children go to school in Solevu.

Out of the 19 villagers interviewed in Yaro, 48% resulted being unemployed. However, unlike the case of Solevu, 42% were employed and 5% self-employed, making the level of employment and unemployment almost even. 5% reported being retired (Fig. 19).

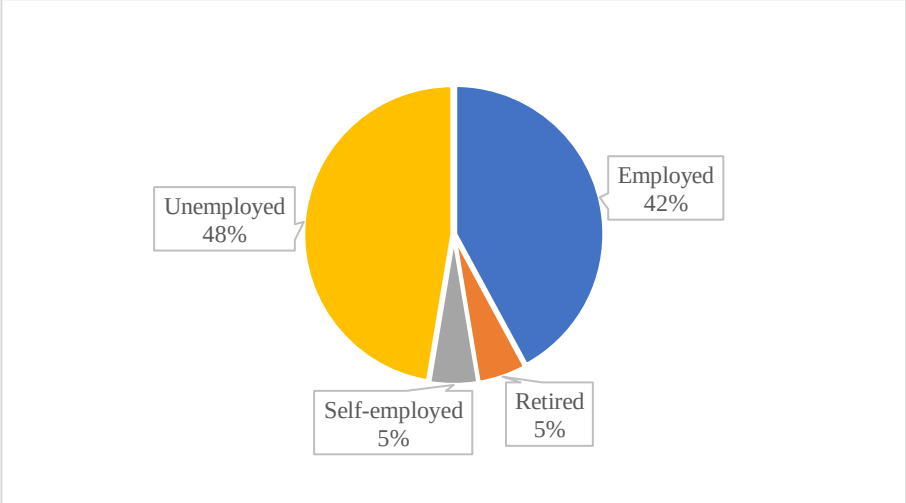

Figure 19. Percentage of employees who are employed, self-employed, unemployed or retired in Yaro.

The interviewees stated that the main source of income in the village is represented by full time jobs, followed by relative's salaries, part time jobs and remittances (from the resorts) (Fig. 20).

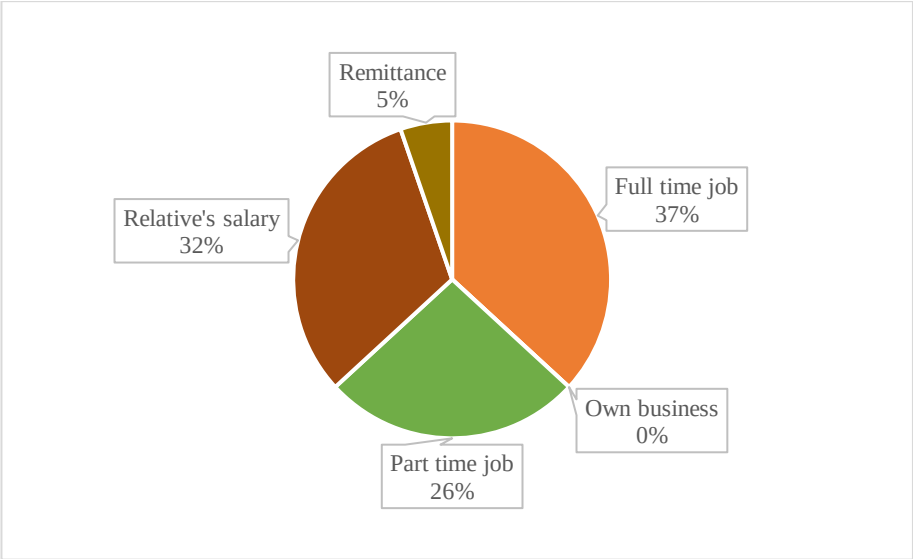

Figure 20. Main sources of income in Yaro.

Even in the case of Yaro, the majority of the interviewees were married (67%) or a de facto couple (17%). Only 11% stated being single and 5% divorced. There were no widowed interviewees (Fig. 21).

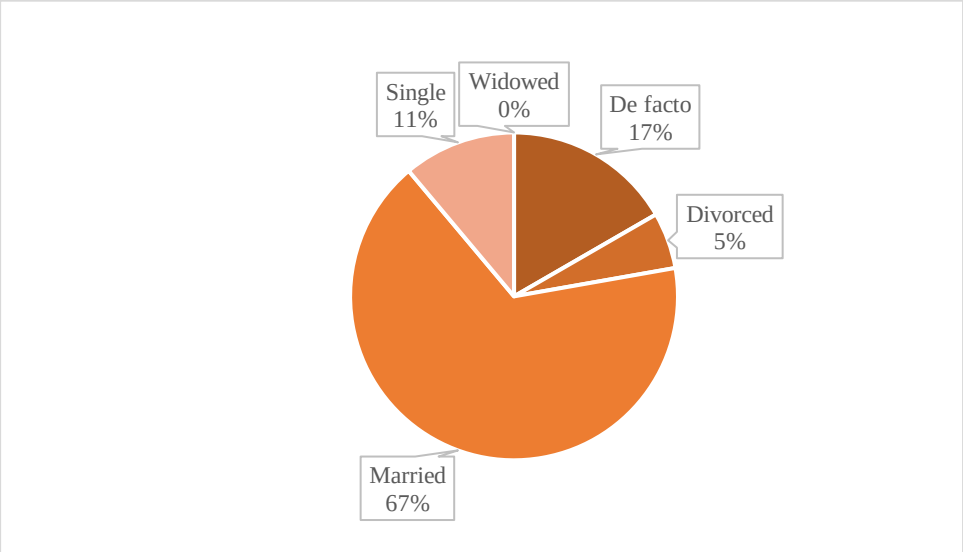

Figure 21. Percentage of interviewees who are married, de facto, single, divorced or widowed in Yaro.

Most of the interviewees in Yaro stated that their households are male headed (84%), with only 16% of them being female headed. No household reported being led by both a woman and a man (Fig. 22).

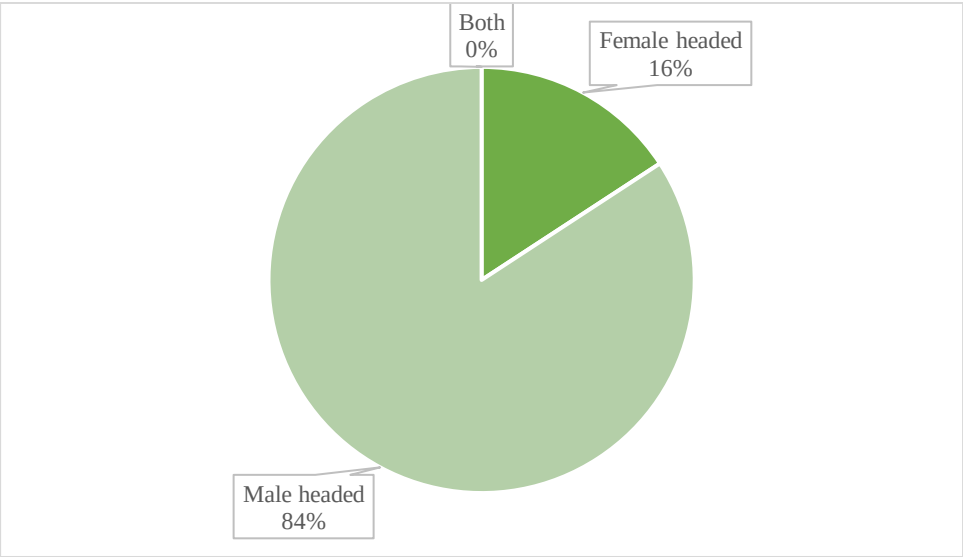

Figure 22. Percentage of households that are female headed, male headed or both in Yaro.

3.3 Water access and use

In both villages, the totality of the interviewees reported having at least one water source.

However, the main sources from which water was collected varied from rainwater to groundwater. Alternatively, during periods of droughts, water cartages were distributed by the government (Fig. 23).

In Solevu there are 2 boreholes of 10-15 metres (1 for half of the village), the 3rd one is used for the school and medical centre. The borehole pumps to the reservoirs and then the water is carried through PVC pipes. The reservoirs are cement tanks of 45 thousand litres and 3m tall; they are placed on higher ground, so water flows thanks to gravity. The borehole is placed at a low level; therefore, the water is pumped into the reservoirs through solar pumps powered by solar panels. One of the boreholes is opened only on Tuesday and Saturday, whereas the other one is opened every day. Approximately every house is connected to the borehole, the different access to water depends on how far from the borehole the house is located. The interviewees reported that the borehole has never dried up, only the smaller wells have. Some houses also have their own wells, which fill the tanks on the roof thanks to solar pumps.

In Yaro there are 2 boreholes, one of which is opened only twice a week for approximately 2-3 hours. The village also relies on personal wells and a spring, which is cleaned every month.

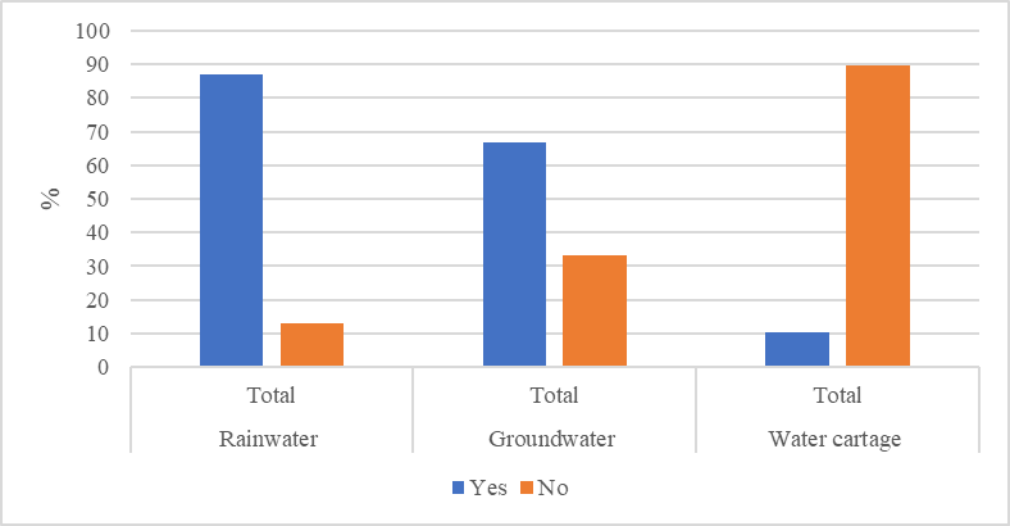

Figure 23. Main sources of water in Solevu and Yaro.

Among the interviewees, some reported having alternative sources of water, such as taking buckets of water from the neighbours[10] when needed.

One of the issues in the water system in the villages was reported being that only the low side of the village receives water due to the reliance on gravity. Therefore, the design of the village should be adapted accordingly. Moreover, the pipes of the system were built in 2009 in Solevu and in 1993 in Yaro and hence they are full of leakages and need renovating. A man interviewed in Solevu worked as a plumber[11] at the resort in the island and explained that he is often called for assistance in both villages. He also stated that he teaches what he learns at the resort to the other villagers, even though many men already know how to fix pipes.

Analysing the main uses of water in the two villages, it was observed that in both most of the water is used for drinking, cooking, bathing and for the laundry (approximately 100%), whereas water was not always used for irrigating (52% "yes" for Solevu and 68% for Yaro) or for the livestock (29% of "yes" for Solevu and 53% for Yaro) (Fig. 24). Rainwater is the main source of water used for drinking, whereas the water from the boreholes or from the spring is used for cooking, cleaning, doing the laundry and irrigating.

[10] For example, Sol_a_02, Sol_b_04 and Yar_a_04
[11] Yar_a_01

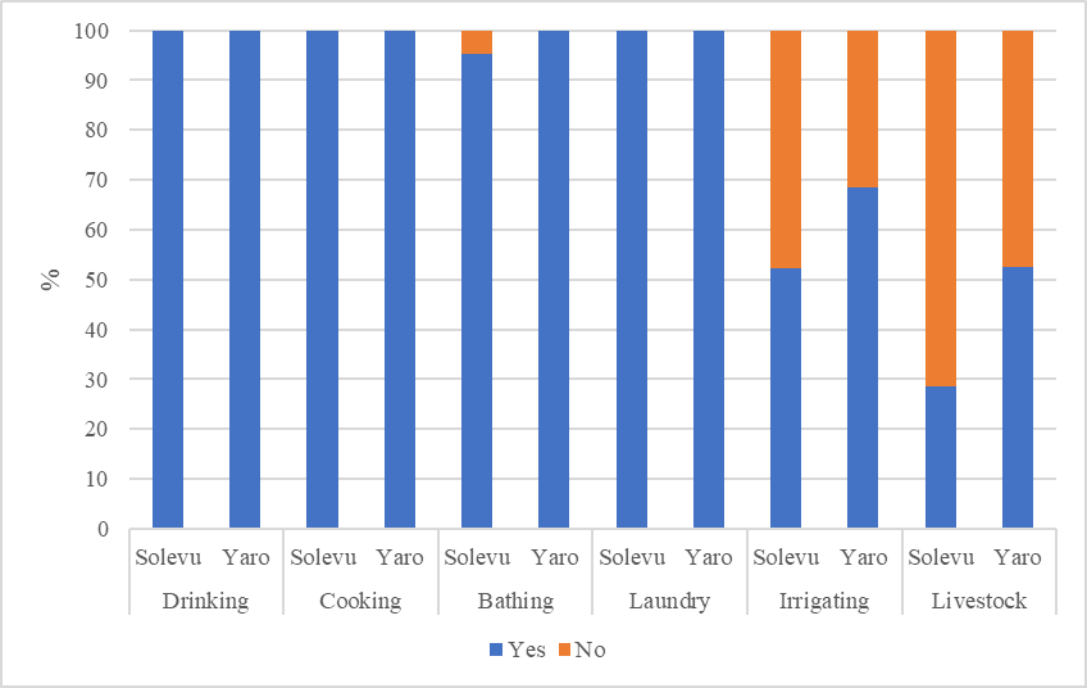

Figure 245. Percentage of interviewees using water for drinking, cooking, bathing, doing the laundry, irrigating and using it for the livestock in Solevu and Yaro.

Moreover, most of the interviewees reported facing both water quantity and water quality issues (Fig. 25). In fact, 82% reported facing water shortages and 57% stated having water quality problems very often. Examples given of water quantity problems were not having enough water for the daily needs; having limited access to a clean water source; facing period rationing of water; experiencing frequent drought conditions and having inadequate water infrastructure and distribution systems. An additional problem was the increase in population[12], making households more numerous. An interviewee also explained that when she was a child (around 30 years ago) there was a river on the hills of the island[13]: water used to be taken from the river for drinking purposes, as well as for bathing and doing the laundry. With the years, the river became a creek and then dried up completely, reducing the amount of water available for the villagers. Besides, interviewees explained facing water shortages when they run out of diesel to make the hydraulic pump work, or when the sun is not strong enough. In fact, solar panels - which are provided by the government - are often used to make electricity.

On the other hand, some of the highlighted water quality problems were the contamination of the water sources; waterborne diseases; poor sanitation systems and issues with water treatment and filtration methods. Regarding contamination, the main causes of it were declared to be dirt accumulation, cyclones, debris, mud caused by heavy rainfall, leaves, frogs, and salt. The interviewees stated that in the past they had never seen the sources as dirty and contaminated as they are now.

[12] Stated for example in Sol_a_07 and Sol_b_03
[13] Sol_b_04

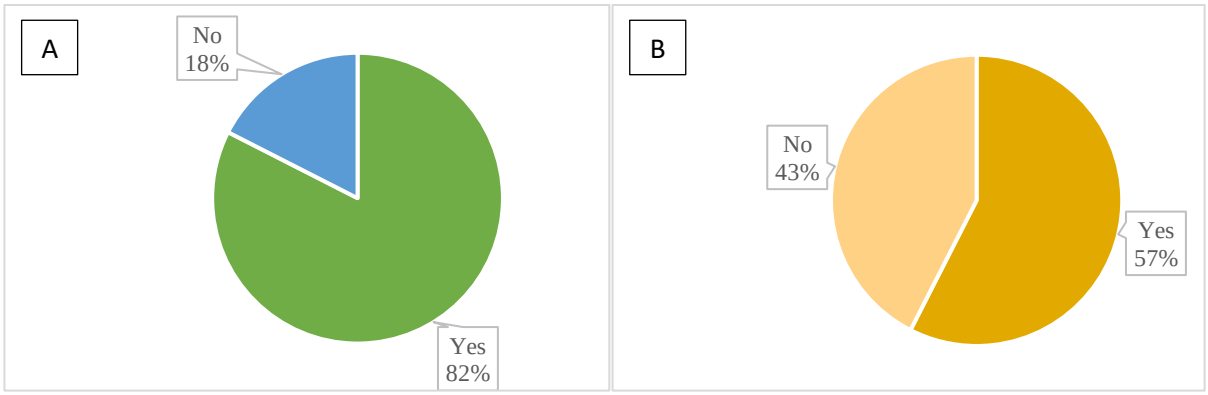

Figure 25. Percentage of interviewees facing water quantity (A) and water quality (B) problems in Solevu and Yaro.

Other sources of contamination were found to be the increase of animals on the island, as well as burning land to farm and cutting trees around the source[14]. In fact, interviewees stated that in the past there were many more trees close to the water sources. The reduced number of trees nowadays also leads to soil erosion when there are heavy rainfalls. Interviewees in Yaro, however, reported that the quality of water is currently better (compared to the past) since activities around the source are not allowed anymore[15].

To prevent contamination, nets are placed on top of the tanks. The villagers are advised to clean the tanks after heavy rainfalls, even though most of them reported not doing so. In addition, gutters are built in plastic and not in corrugated iron to avoid contamination; however, the roofs of the houses are mostly made of corrugated iron, making the system not suitable for rainwater harvesting.

Both villages have their own water committee. They are composed of 8 people each, and at least 2 women are required to make it effective. Nevertheless, in Yaro there are no women in the committee. Usually, women serve the role of treasurers or secretaries. The committee is nominated and elected, and it takes care of the maintenance of the infrastructure and takes decisions on water access for the village, such as opening and closing the main tap.

As shown in figure 25, the villages face problems related to water quantity as the pressure is unreliable. Therefore, some interviewees reported receiving only half a bucket of water a day[16].

When shortages are experienced, especially during the dry period from May to October, the villagers require water to the government. 1987 was reported being the driest year: the villagers requested water cartages, which were however not distributed as the government had to provide water to the farthest islands. Moreover, schools in the villages close during water shortages: in the same period as the interviews were conducted, children were going to school only for half a day due to the lack of water.

An interesting result was obtained by analysing the percentages of people who face water shortages and water quality issues divided by gender (Fig. 26). In fact, it was observed that the percentage of women having water shortages was higher compared to men, respectively 52% against 30%. Moreover, 35% of women stated facing

[14] Sol_a_04
[15] Sol_b_04, Yar_a_01
[16] Source: informal conversation with one of the villagers

water quality problems compared to 22% of men. Women also reported needing more water due to the nature of their work, as they are responsible for taking care of the household and its members, including children and the elderly.

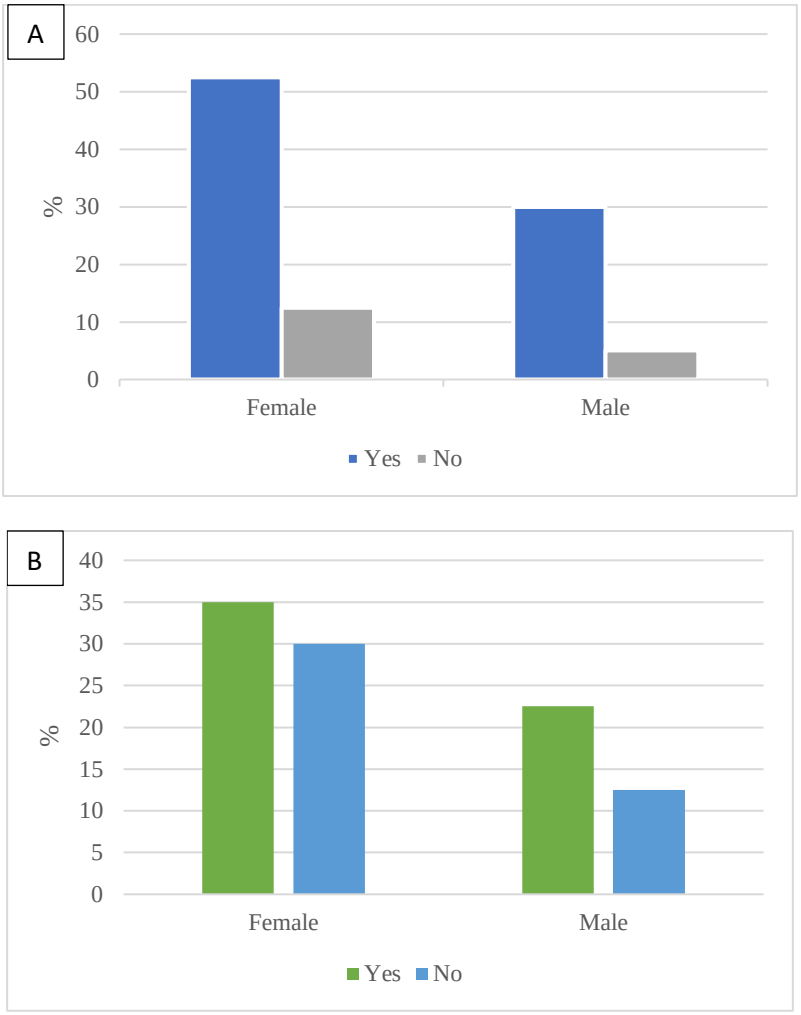

Figure 266. Percentage of interviewees facing water shortages (A) and water quality problems (B) in Solevu and Yaro, divided by gender.

Even though rainwater is mostly used for drinking, when the villagers run out of it they drink the water from the wells, which is used as backup. The majority of the interviewees treat the water before drinking it, either by boiling it (70%) or by using chlorine tablets (3%). The latter are provided by the Ministry of health; however, some of the villagers don't know the ratio of water to use the tablets with. Moreover, NGOs such as *Fiji Vinaka* have distributed filtration buckets to filter rainwater. An outstanding 40% of the interviewees stated not treating water before drinking it (Fig. 27).

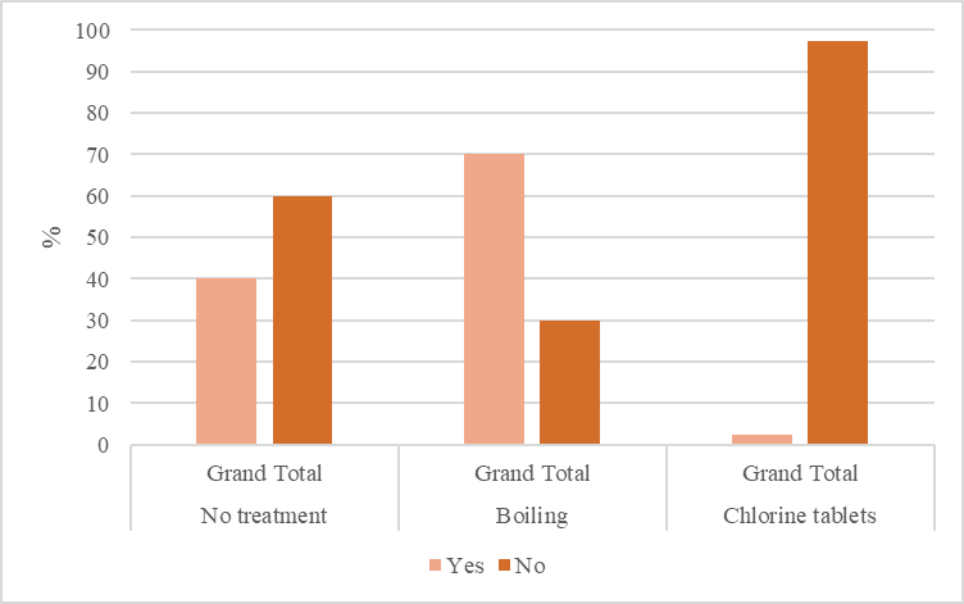

Figure 27. Type of water treatment adopted in Solevu and Yaro.

As they frequently experience drought conditions and water shortages, the villagers have adopted some water conservation measures. For example, they limit the amount of freshwater used for bathing (in 43% of the cases), they bathe in the sea (in 28% of the cases), they collect and store rainwater (79% of the cases), they reduce the amount of water used in the bathroom for the toilet (23% of the cases), they educate family members about the importance of saving and conserving water (46% of the cases) and finally they participate in water conservation campaigns (11% of the cases). One woman in particular explained that she has been doing awareness raising inside the village and she has been advocating for people to use the water wisely during village meetings. Other methods of conservation are collecting water in drums and buckets, make hand-dug wells and open the boreholes only twice a week.

An additional important way of saving water is the reuse of greywater. 74% of the interviewees stated adopting this practice (Fig. 28). Greywater is collected and then reused for various purposes, such as for cleaning the house, to flush the toilet, to wash the clothes, to water the plants and the vegetable garden, and to clean the porch.

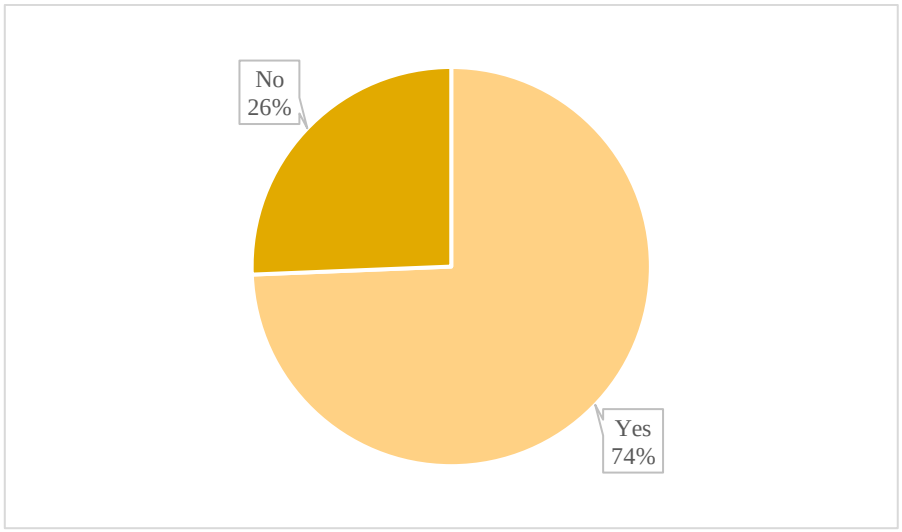

Figure 28. Percentage of interviewees reusing greywater for other purposes in Solevu and Yaro.

Rainwater is usually stored in tanks: 75% of the interviewees reported having a water tank. These tanks were either bought by the villagers, supplied by the resorts, given by charity organisations, or received through village projects. The tanks cost approximately 500$ and last for about 20 years.

When comparing the percentage of interviewees having a water tank with the type of household, it was observed that male headed households are much more likely to possess a tank (65%). On the other hand, only 7.5% of the female headed households own a tank (Fig. 29).

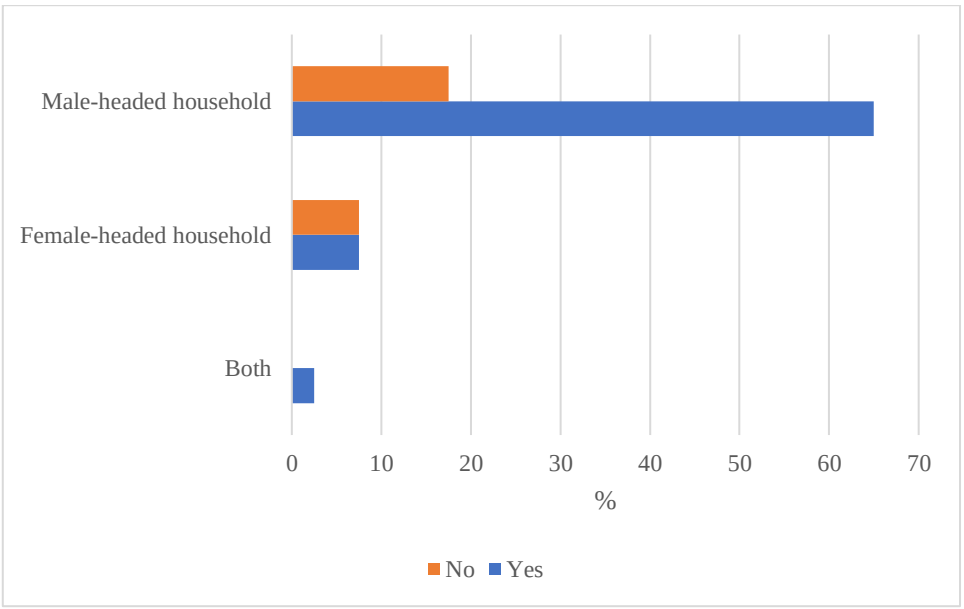

Figure 29. Percentage of interviewees having a water tank divided by type of household, in Solevu and Yaro.

3.4 Sanitation

Concerning sanitation, the vast majority of interviewees used flush toilets (72%), whereas a limited number reported having water seal toilets (25%) and even less had pit toilets (5%). No households had composting toilets or practiced open defecation (Fig. 30).

Water for the toilets is taken from the boreholes or the spring.

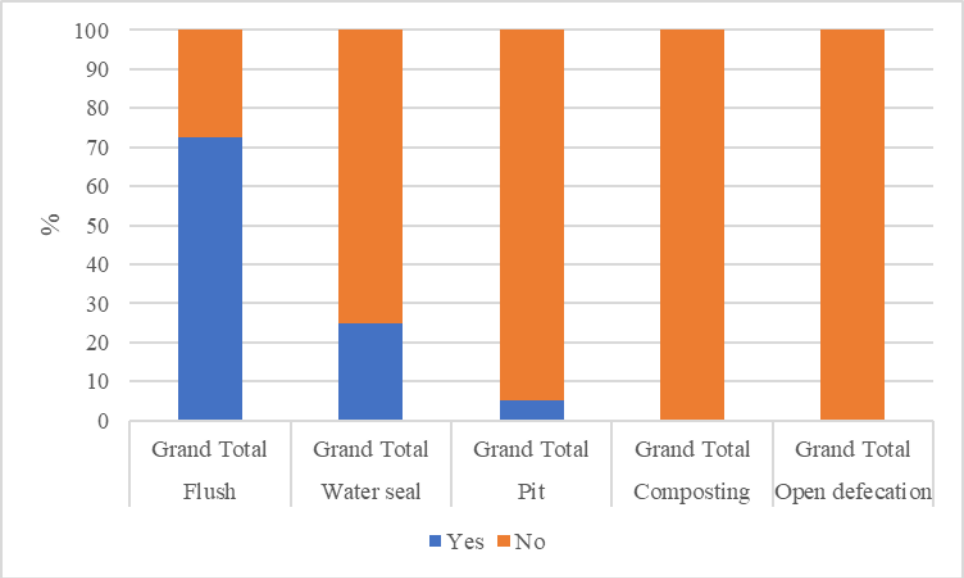

Figure 30. Percentage of interviewees having a flush, water seal, pit or composting toilet or practicing open defecation in Solevu and Yaro.

3.5 Climate change

As previously stated, the Republic of Fiji is extremely vulnerable to the effects of climate change. Therefore, the survey contained a specific section regarding questions on which changes - related to climate change - have been perceived by the villagers and to what extent.

For instance, concerning water bodies, the interviewees were asked if they are experiencing conditions of more or less water compared to the past and if the water is of better or worse quality (Fig. 31). Interesting answers were given, as nearly the same percentage of villagers (40%) believes having more water than the ones who think there is currently less water available (42%). In the case of quality, double the number of interviewees (42%) stated having water of worse quality compared to better quality (22%). Even though some interviewees stated that bush fires and continuous and heavy rainfall- which have increased lately due to climate change- worsen water quality, these percentages could be affected by other compounding factors influencing water quantity and quality, not exclusively climate change. For example, the increase in population reduces water availability whereas deforestation and burning the trash decrease the quality of water.

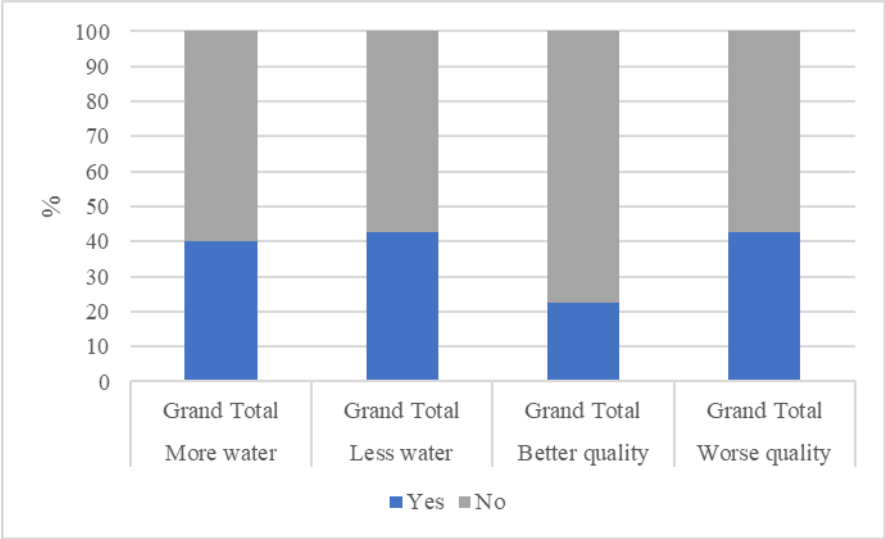

Figure 31. Percentage of interviewees perceiving changes in water in the last 10 years.

In fact, when analysing the percentage of interviewees who believe that there is a relationship between the perceived changes in water and climate variation (Fig. 32), a minor portion who does not believe it is observable, which can be meaningful in a small sample of interviewees. However, the majority believes that there is a connection between these two factors.

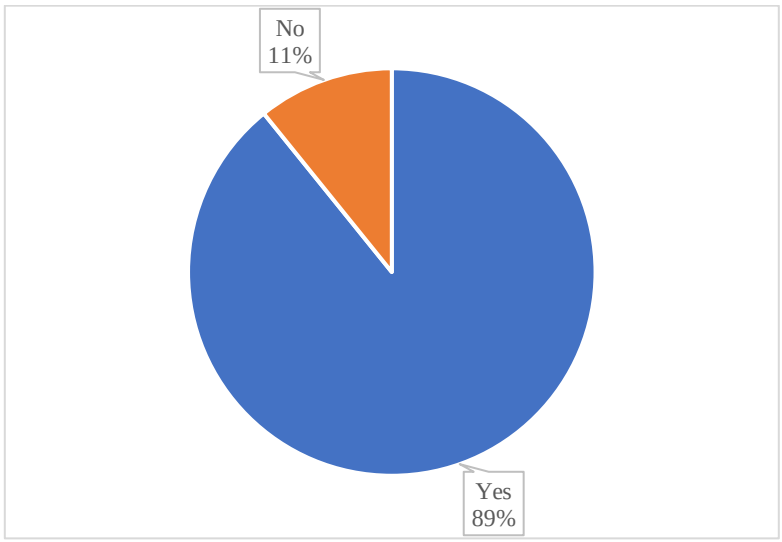

Figure 32. Percentage of interviewees believing there is a relationship between the observed changes in water and climate change.

Observing these percentages with a gender perspective, the women who stated believing that there is a correlation between climate and the perceived changes in water are more than the man stating the same: 55% of women compared to 27% of men (Fig. 33). This could be due to the higher number of women interviewed, but also to a greater awareness of women in terms of climate change.

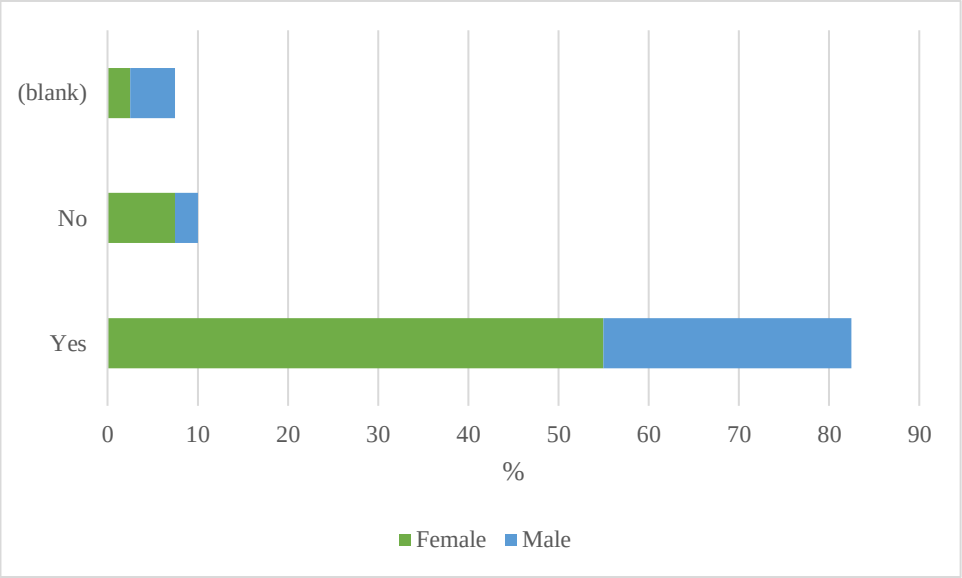

Figure 337. Percentage of interviewees who believe there is a relation between climate and the changes in water, divided by gender.

The main changes perceived in water bodies were saltwater intrusion (49%), lowering of the water table (40%) and algal blooms (11%). These changes referred mainly to the boreholes, where saltwater intrusion was reported being frequent due to sea level rise. Other observed changes were, for example, the presence of brownish water.

When asked to choose between "normal weather patterns" or "climate change" as the main cause of these changes in water bodies, most of the interviewees selected the second option, "climate change" (60% yes, 40% no, considering both Solevu and Yaro) whereas the option "normal weather patterns" obtained 22% of yes and 78% of no between the two villages (Fig. 34). As a matter of fact, some interviewees stated that they believe that water quality and quantity are affected only by weather seasonality[17], which makes them fluctuate through the year. Nevertheless, changes in seasonality have been observed, which create a lag effect in rainfall: during the wet season the villagers receive suppressed rainfall, which is instead received during the first weeks of the dry period.

[17] For example, Sol_b_05, Sol_c_01 and Yar_b_02

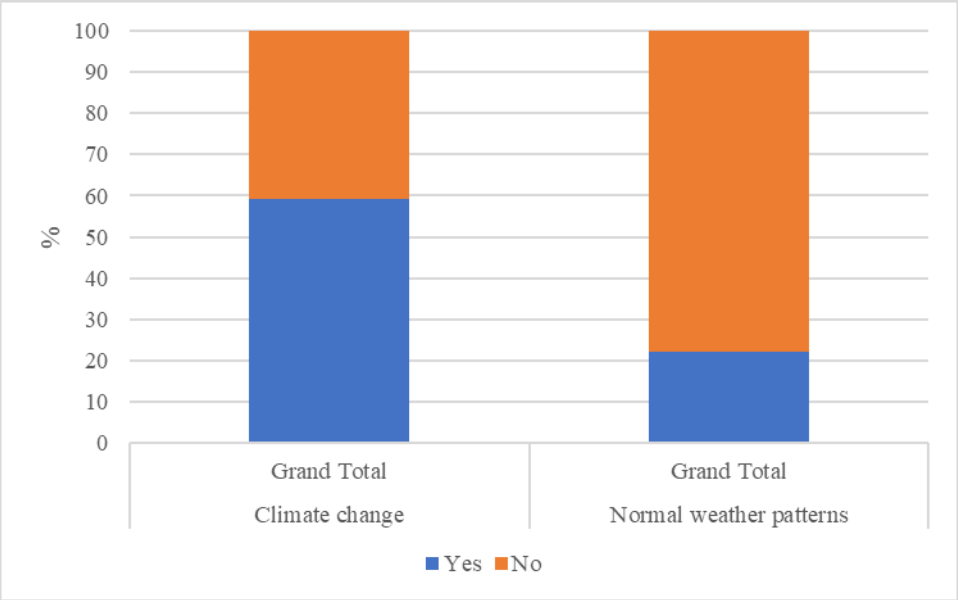

Figure 348. Percentage of interviewees believing that the perceived changes in water bodies are caused by climate change or by normal weather patterns.

Analysing more in detail the perceptions of climate change in the island, the interviewees were presented with a table listing various variables (e.g. temperature, rainfall, intensity of cyclones…) and had to describe whether they have observed, in the past 30 years, an increase, a decrease or no change at all in the variable in question. The results are reported in figure 35. As it can be seen in the graph, most of the variables have reportedly been increasing: temperature, changes in crops, cyclone intensity, cyclone frequency, droughts and sea level rise. Rainfall is the only variable that has been perceived as decreasing, whereas no change has been observed in floods.

More specifically, interviewees said that higher temperatures during the day and lower during the night have been registered, together with higher waves in the sea. Moreover, sea level rise is causing saltwater intrusion in the borehole, and it is forcing families to relocate their houses.

In the case of extreme events, early warning systems are adopted and performed by the National Disaster Management Office (NDMO) through social media, TV, and radio. The latter is especially used in rural areas, where information is given in 3 languages: Hindi, English and I'Taukei).

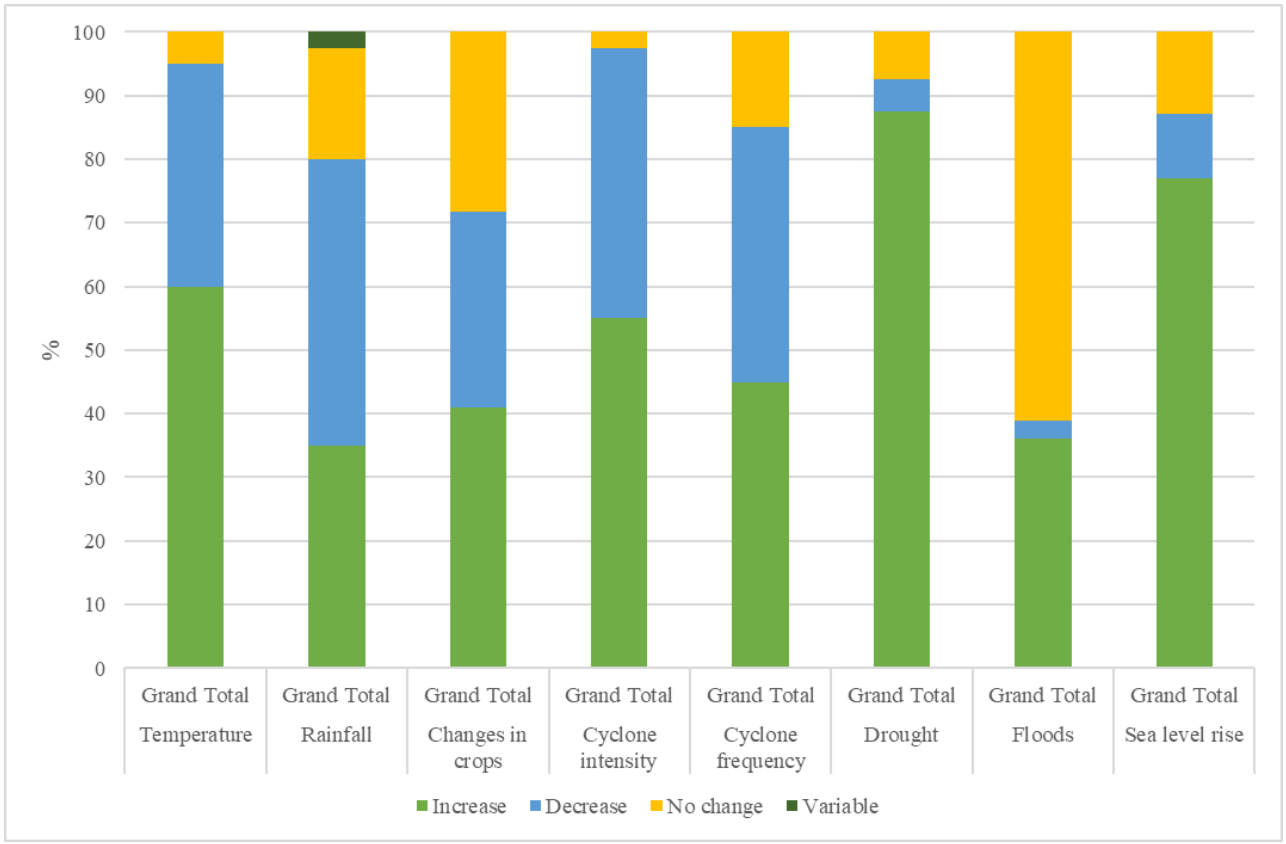

Figure 35. Changes perceived (increase, decrease, no change) in the last 30 years in various variables.

One interviewee, a 69-year-old woman[18], explained that she would like to attend trainings and receive information regarding climate change as she only learnt about it through personal experience. She also said that, in her opinion, the village of Solevu is not aware of the changes that are happening and will happen in the near future. She reckons the village will go underwater in the next 20 to 50 years. On her side, she is educating her children and grandchildren about climate change.

A compounding factor to climate change is waste management. In fact, most of the waste in the two villages is not recycled: on the other hand, tins and cans are buried and plastic and paper are burnt in incinerators or directly in the villagers' gardens. This generates polluting smokes which release heavy metals and toxic chemicals that are harmful for the environment and for the villagers' health. Nevertheless, some interviewees reported not being aware of the issues caused by burning plastic[19].

3.6 Governance

One section of the survey was dedicated to governance, meaning the participation in community water committees and the relative position in the committee.

[18] Sol_a_07
[19] Source: informal conversation with the villagers

The majority of the interviewees reported not participating in the committees (79%), with only 21% taking part in them (Fig. 36). Of the interviewees who reported participating in the committees, most of them stated being members with no specific role. On the other hand, one interviewee occupied the role of deputy[20] secretary, with the main role of cleaning the areas around the spring and boreholes every month.

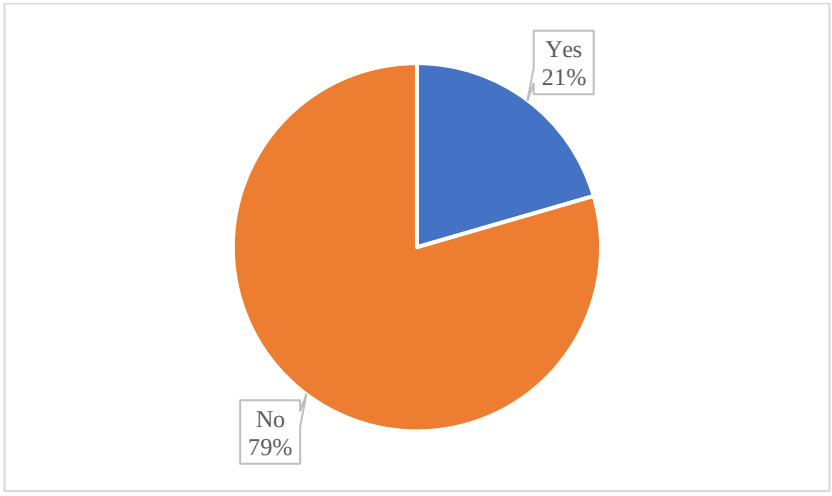

Figure 36. Percentage of interviewees taking part in village water committees in Solevu and Yaro.

These results can be disaggregated by sex, as shown in figure 37. It is observable how less women reported participating in the committees, even though the number of women interviewees was higher compared to the men. In fact, 7.5% of women and 12.5% of men participate in these committees.

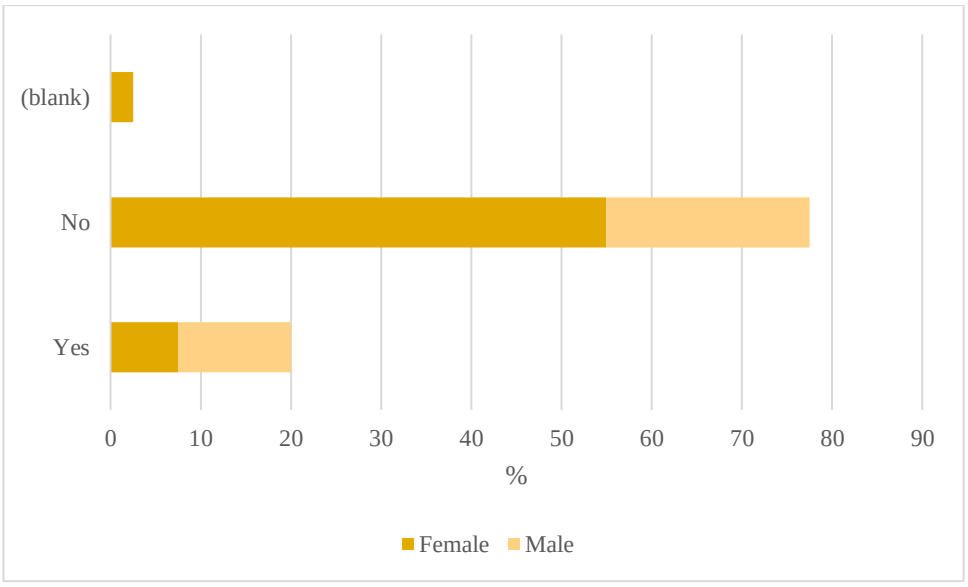

Figure 37. Percentage of interviewees who participate in community water committees divided by gender.

3.7 Education and training

The final part of the survey included questions related to education and training.

[20] Yar_b_03

First of all, interviewees were asked whether they had ever participated to trainings on water, such as water tank uses, rainwater harvesting or similar or to other trainings more concentrated on women emancipation. Only 25% of the interviewees reported taking part in such trainings (Fig. 38).

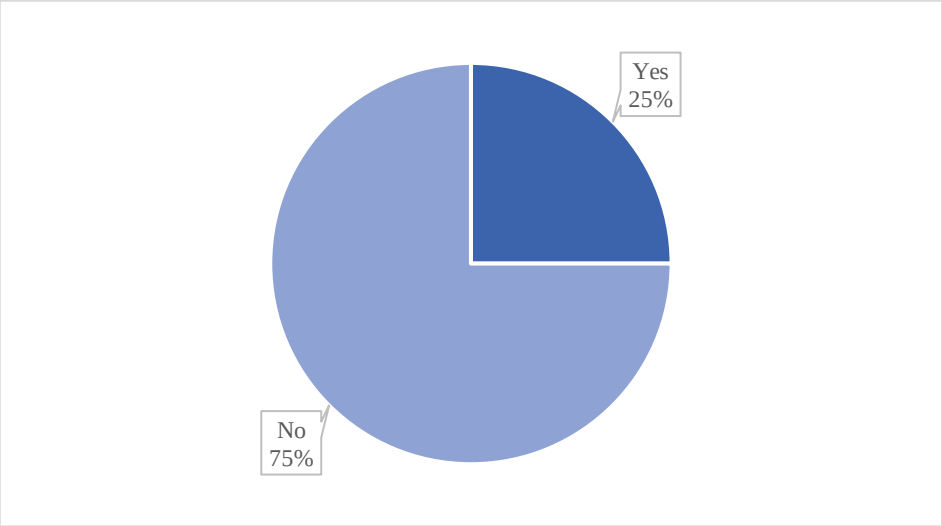

Figure 38. Percentage of interviewees taking part in trainings in Solevu and Yaro.

When disaggregated by sex, it was seen that more women reported never having participated in such trainings compared to men, respectively 52.5% compared to 22.5% (Fig. 39). The same percentage (12.5%) of women and men stated having taken part in a training.

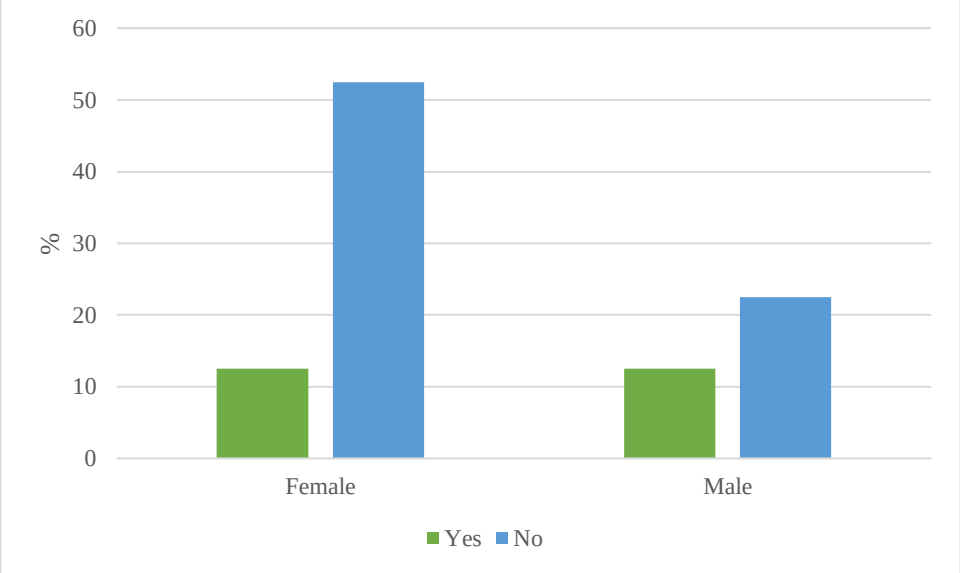

Figure 39. Percentage of interviewees who have taken part in trainings in Solevu and Yaro, disaggregated by sex.

The trainings were mostly delivered by the Government (40%), the Department of water and sewerage (20%), NGOs (20%) and village water committees (20%).

The main activities performed were:

- Awareness raising about water usage and conservation;
- Explaining how to build the base for the tanks and how to maintain the tanks;

- Filtration training: SSF (Slow sand filtration);
- Explaining how to lay and fix pipes;
- Providing filter buckets;
- Training on maintaining water infrastructure.

Moreover, a different kind of training was delivered to the women in the villages on handicraft and how to create decorations using recycled materials. Nevertheless, women stated that they would like to attend trainings[21] on how to fix pipes and preserve water, as these kinds of trainings are only delivered to men.

When the interviewees stated not having participated in trainings, they were asked the reason for it. The most frequent answers were that in their opinion no training had been conducted (53%); that they were not aware of any training (32%); that they lived far from the village (5%); that they didn't have time due to work or children (5%) or that they had not been informed (5%). Most of these latter answers were given by women, who are the ones who are usually not aware of trainings or don't have time due to other tasks (Fig. 40)

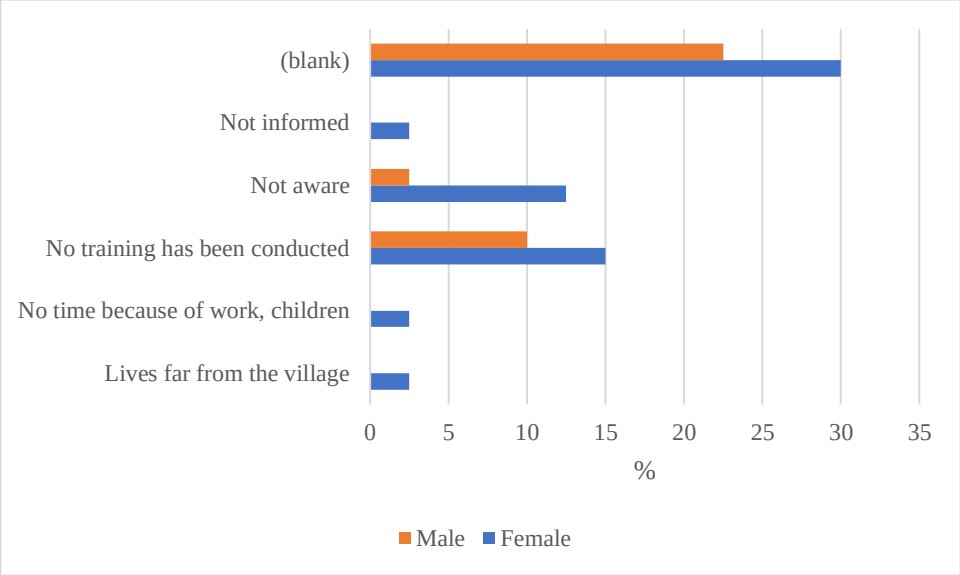

Figure 40. Reasons why interviewees have not participated to trainings in Solevu and Yaro divided by gender.

Interviewees also reported receiving assistance to complete the trainings in some cases. This assistance varied from financial to material and was given mainly by the Government or NGOs.

Comparing the percentages of interviewees who received assistance with those who haven't, a slight difference is observable: 45% stated being given assistance of some form, whereas 55% reported not having received assistance of any kind (Fig. 41 A). On the other hand, comparing the situation of women and men, more men (10%) declared having received assistance with respect to women (2.5%) (Fig. 41 B).

[21] For example, Sol_a_07 and Yar_c_07

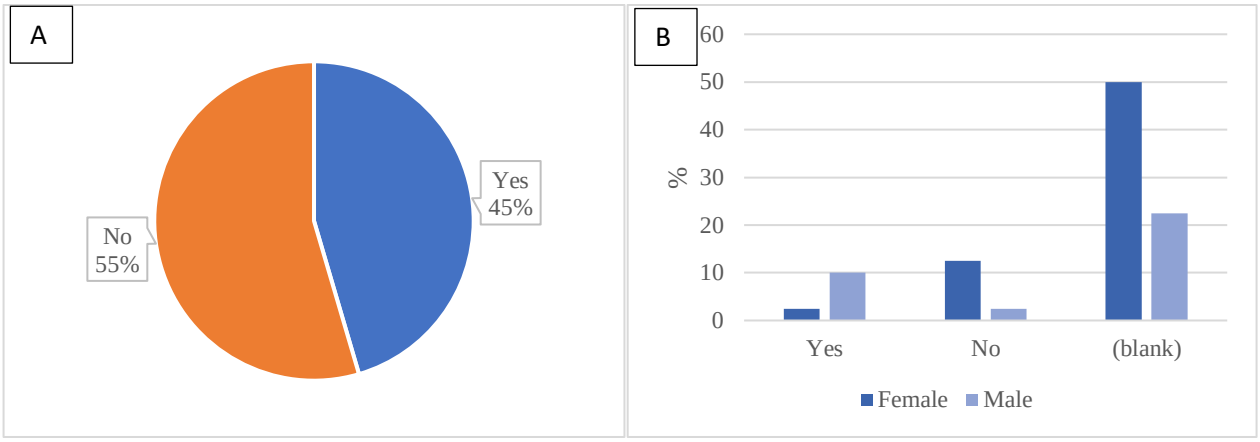

Figure 41. Percentage of interviewees having received assistance for completing the training in Solevu and Yaro (A) and disaggregated by gender (B).

The final question of the survey focused on the knowledge of the interviewees about gender equality and awareness raising related to it. The majority of respondents stated not being aware of gender equality related campaigns or trainings (75%). Only 25% knew about trainings focused on women, such as a training on how to produce handicraft (Fig. 42). Nonetheless, no campaign was conducted to increase awareness on gender equality and water.

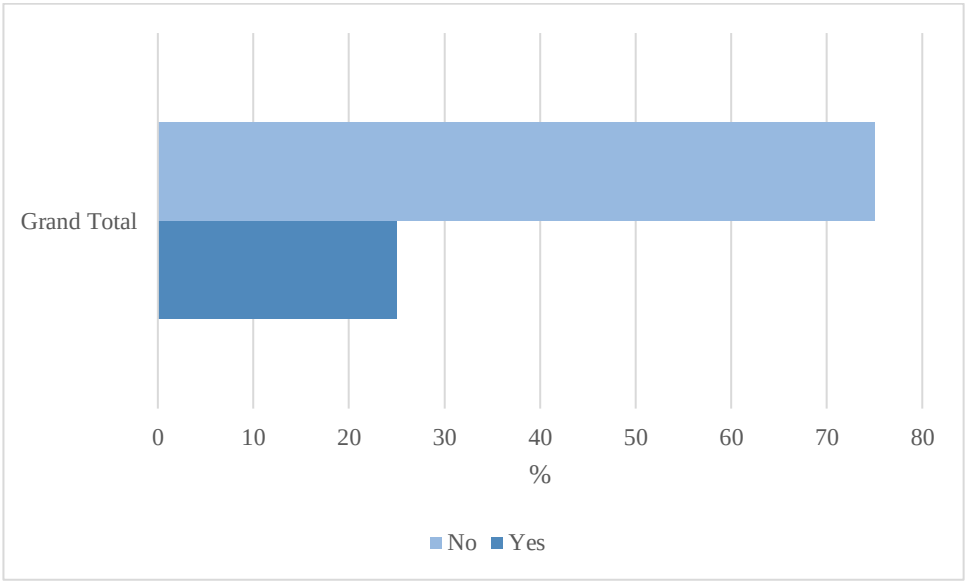

Figure 429. Percentage of interviewees who are aware of gender equality campaigns or trainings in Solevu and Yaro.

This question led to other interesting results in respect of gender: women and men told their perspective about who the decision-makers in the households and in the villages are. Indeed, most of the villagers (including both women and men) defined the men as the leaders who decide inside the household. However, some men stated that they would like things to change for their children[22], especially their daughters, and that they try to educate their sons to be fair to women. Some of the women also reported that men are the decision-makers, but they have issues with drinking[23], which leads to misbehaviour with women. In one case, a man stated that

[22] For example, Sol_a_01 and Yar_a_01
[23] Sol_a_07, Sol_b_09

in his opinion women are the ones who run the village as they tend to stay at home during the day while the men are out in the fields working, and it is positive.

Another relevant information obtained was the presence of a women's club in both the villages. Nevertheless, different opinions were obtained regarding the main topics discussed during the meetings of these groups. In fact, some women said that the meetings are about how to dress, how to fix their hair, and how to organise functions in the villages[24]. On the other hand, other women mentioned talking about their issues between themselves[25], for example in relation to water usage, and then express them to the village elderly, although they also reported that this rarely leads to changes being implemented.

3.8 Comparison between perceptions and meteorological data

The comparison between the perceptions of the interviewees about climate change and the actual meteorological data registered in Fiji is reported in the following part. The original plots of the meteorological data can be seen in Annex III.

Regarding temperature, considering the perceptions of the villagers of both Solevu and Yaro, it is observable that the majority of them (60%) expressed having experienced an increase in temperature in the past 30 years (Fig. 43A). This result is in line with the meteorological data, as both the maximum and minimum temperatures show an increasing trend, especially the minimum temperature which has increased of more than 2°C since the 1990s. The maximum temperature has fluctuated more but has increased of 1.5°C since 2010 (Fig. 43 B, C). Therefore, the answers obtained from the villagers were in line with observations.

[24] For example, Sol_a_06 and Yar_a_02
[25] Sol_a_05

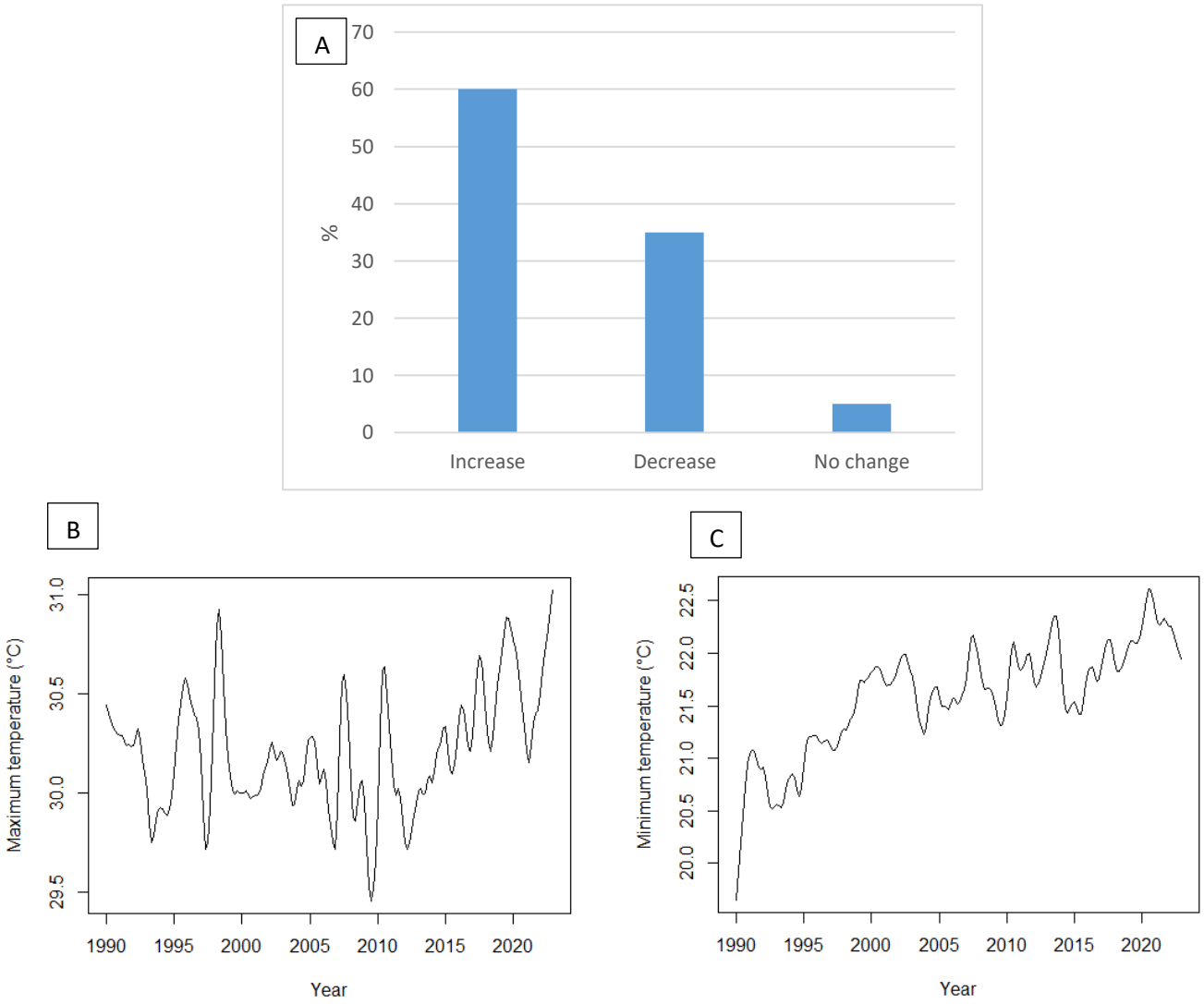

Figure 43. A: Perceptions of the interviewees regarding temperature, as if it has increased, decreased or experienced no change; B: Trend of the maximum temperature; C: trend of the minimum temperature registered in Nadi.

The second analysed variable is rainfall. In this case, most of the interviewees (45%) declared having observed a decrease in rainfall in the past 30 years. However, 35% stated that rainfall has instead increased. In addition, 17.5% reported having seen no change at all in rainfall and a small percentage, 2.5%, stated that rainfall has been variable (Fig. 44A). Observing the meteorological data, the trend is increasing (Fig. 44B), not confirming the people's perception.

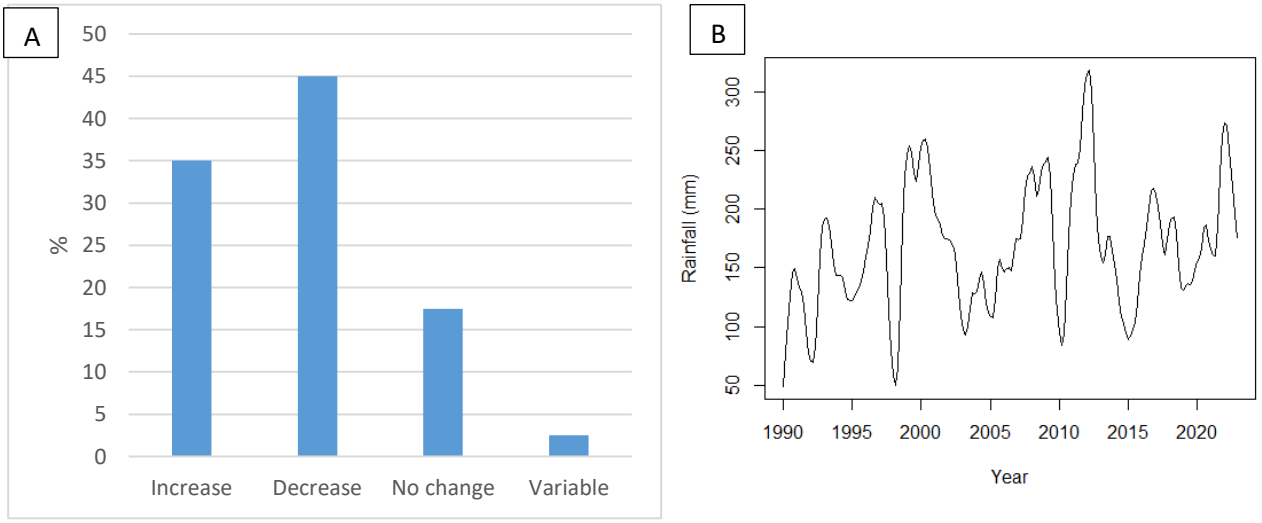

Figure 44. A: Changes perceived in rainfall by the interviewees as in increase, decrease, no change or variable; B: trend of rainfall based on meteorological data obtained in Nadi.

Another variable taken into account is the frequency of tropical cyclones. 45% of the interviewees reported having experienced an increase in cyclone frequency in the past 30 years, whereas 40% declared having observed a decrease instead. 15% have experienced no change at all (Fig. 45A). Comparing these results with the meteorological data, it is observable from the trend how cyclones have been quite stable since the 1990s and started to increase around 2015 (Fig. 45B). In this case, the perceptions are in line with the meteorological data for nearly half of the interviewees.

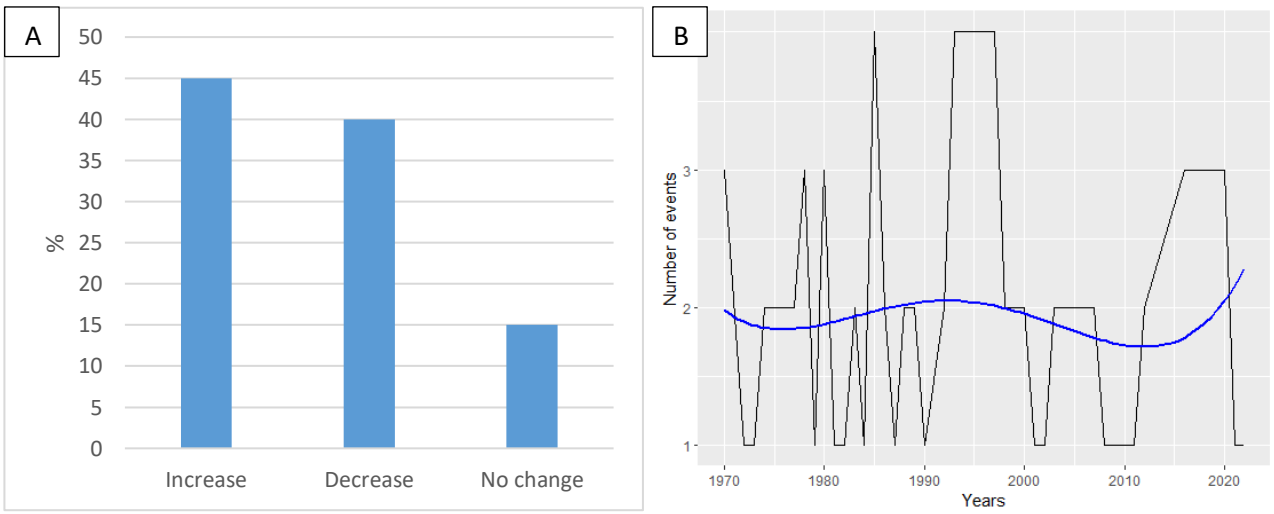

Figure 45. A: Changes perceived in tropical cyclones by the interviewees as in increase, decrease or no change; B: trend of tropical cyclones based on meteorological data. The blue line represents the polynomial trendline of order 4.

As for drought frequency, the vast majority of interviewees (87.5%) reported having observed an increase in drought frequency in the past 30 years. Only 5% declared having experienced a decrease and 7.5% answered no change (Fig. 46A). Observing the trend, it can be seen that the years of drought have been increasing since the 1960s (Fig. 46B), as perceived by most of the interviewees.

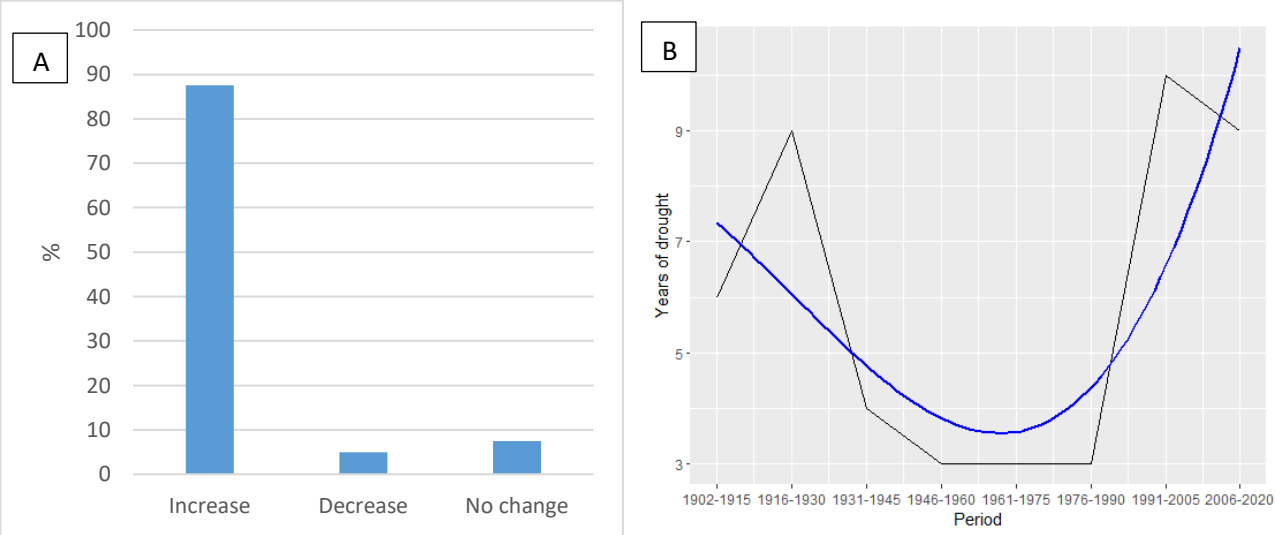

Figure 106. A: Changes perceived in drought frequency by the interviewees as in increase, decrease or no change; B: trend of drought frequency based on meteorological data. The blue line represents the polynomial trendline of order 3.

Furthermore, the interviewees were asked their perception about the increase, decrease or no change in floods in the past 30 year. In this case, 61% of the villagers stated not having observed any change in the number of floods in their island. On the other hand, 36% perceived an increase and only 2.7% a decrease (Fig. 47A). These percentages are not in line with the trend observable from the meteorological data, which has been increasing since the 1980s from 2 events a year to approximately 8 events a year in 2009 (Fig. 47B). It must be specified that, in fact, data available for floods was only present until the year 2009.

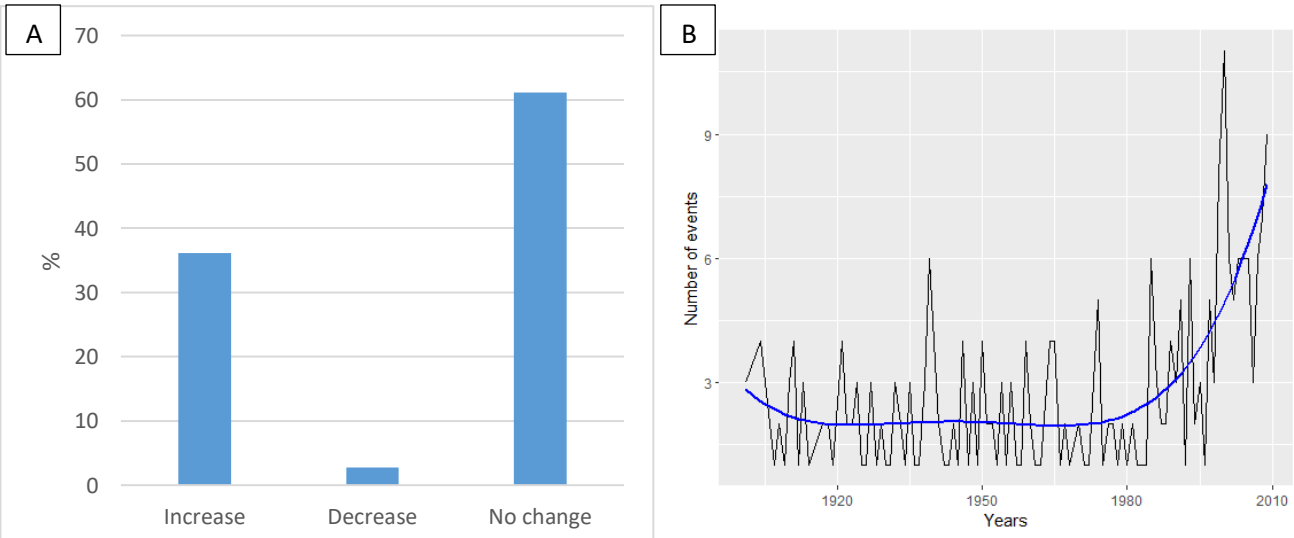

Figure 47. A: Changes perceived in flood frequency by the interviewees as in increase, decrease or no change; B: trend of flood frequency based on meteorological data. The blue line represents the polynomial trendline of order 4.

Finally, sea level was considered. The perceptions of the interviewees revealed a majority of "increase" answers (77%), with only 10% perceiving a decrease in sea level. 12% stated having observed no change (Fig. 48A). The results are in line with the observed meteorological data, as the trend has been increasing since the 1990s (Fig. 48B).

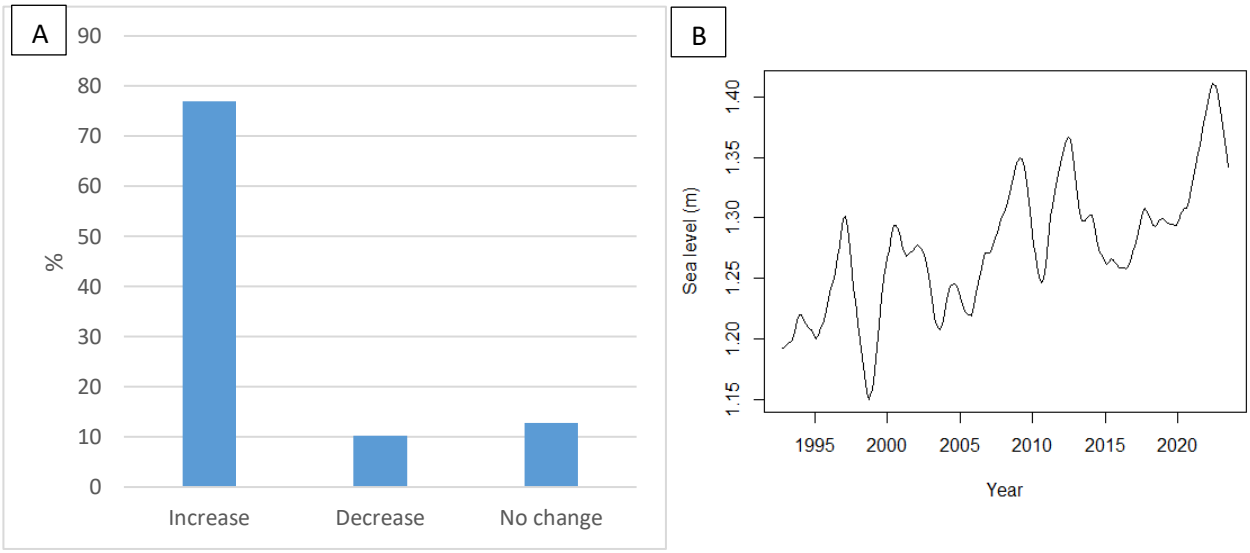

Figure 48. A: Changes perceived in sea level by the interviewees as in increase, decrease or no change; B: trend of sea level based on meteorological data.

In addition, Ordinary Least Squares regressions were performed between the meteorological variables and some socio-demographic variables of the interviewees, such as the age, gender, type of household, participation to the water committee and participation to trainings. In the regressions, comparisons groups were considered for the categorical and dummy variables:

- The variable Female was compared to Male
- Female headed was compared to Male headed
- Participates to water committee was compared to not participating to the committee
- Participated to trainings was compared to not participating to trainings.

Six levels of significancy of the p-value were considered, by applying the following codes:

0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

First of all, if observing the regression between cyclone frequency and the socio-demographic variables (Tab. 4), a negative correlation can be found between gender and cyclone frequency. The significance falls in the interval between 0.05 and 0.1. By observing the value of the estimate, it is observable that women are less likely than men to state that cyclone frequency has increased.

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.706333	0.510227	5.304	8.20E-06	***
Age	-0.005958	0.010134	-0.588	0.5607	
Female	-0.615709	0.357758	-1.721	0.0949	.
Female.headed	0.164373	0.451659	0.364	0.7183	
Participates.to.water.committee	-0.305495	0.396383	-0.771	0.4465	
Participates.to.trainings	0.218862	0.358188	0.611	0.5455	

Table 4. Results of OLS regression between cyclone frequency and socio-demographic variables.

Additionally, the OLS regression for floods and the socio-demographic variables resulted in two significant negative correlations (Tab. 5). In both cases, the significance level is between 0.01 and 0.05. First, it is observable that female headed households are less likely than male headed households to state that floods have increased; moreover, people who take part in the water committee are also less likely than people who don't take part in the committee to say that floods have increased in the past 30 years.

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.491986	0.292802	8.511	2.98E-09	***
Age	-0.002883	0.005821	-0.495	0.6242	
Female	0.246695	0.194362	1.269	0.2148	
Female.headed	-0.541181	0.255443	-2.119	0.0431	*
Participates.to.water.committee	-0.53014	0.215581	-2.459	0.0204	*
Participates.to.trainings	0.087024	0.193417	0.45	0.6562	

Table 5. Results of OLS regression between floods and socio-demographic variables.

Moreover, some negative correlations were also found with sea level (Tab. 6). Both of the significance levels are between 0.05 and 0.1. In fact, females were found to be less likely than men to state that sea level has increased, as well as people who participate to water committees compared to people who do not participate.

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	3.062723	0.353678	8.66	6.77E-10	***
Age	0.001247	0.007024	0.178	0.8602	
Female	-0.468187	0.247989	-1.888	0.0681	.
Female.headed	0.007555	0.31308	0.024	0.9809	
Participates.to.water.committee	-0.480072	0.274764	-1.747	0.0902	.
Participates.to.trainings	-0.240259	0.248288	-0.968	0.3405	

Table 6. Results of OLS regression between sea level and socio-demographic variables.

The results of the regression between the temperature and the socio-demographic variables are reported in table 7, with non-significant correlations recorded.

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.817665	0.53105	5.306	8.16E-06	***
Age	-0.005125	0.010547	-0.486	0.63	
Female	-0.31246	0.372358	-0.839	0.408	
Female.headed	-0.17098	0.470092	-0.364	0.718	
Participates.to.water.committee	-0.414464	0.41256	-1.005	0.323	
Participates.to.trainings	-0.080461	0.372806	-0.216	0.83	

Table 7. Results of OLS regression between temperature and socio-demographic variables.

The same results can be obtained when considering the regression between rainfall and the variables, as shown in table 8, where no correlation is observed:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.024715	0.510841	3.963	0.000404	***
Age	0.005454	0.010122	0.539	0.593864	
Female	-0.51443	0.351174	-1.465	0.153021	
Female.headed	0.451013	0.481862	0.936	0.356518	
Participates.to.water.committee	-0.439201	0.389344	-1.128	0.267952	
Participates.to.trainings	0.137366	0.354663	0.387	0.701171	

Table 8. Results of OLS regression between rainfall and socio-demographic variables.

If considering cyclone intensity, no significant correlation is present (Tab. 9).

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.050491	0.556852	3.682	0.000847	***
Age	0.004722	0.01106	0.427	0.672267	
Female	-0.03253	0.39045	-0.083	0.93412	
Female.headed	-0.580709	0.492932	-1.178	0.247456	
Participates.to.water.committee	-0.2373	0.432605	-0.549	0.58713	
Participates.to.trainings	0.14817	0.390919	0.379	0.70717	

Table 9. Results of OLS regression between cyclone intensity and socio-demographic variables.

As for droughts, no relevant correlation was found, as shown in table 10.

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	2.810263	0.286131	9.822	3.52E-11	***
Age	0.001087	0.005683	0.191	0.85	
Female	-0.170269	0.200628	-0.849	0.402	
Female.headed	0.0725	0.253287	0.286	0.777	
Participates.to.water.committee	-0.01143	0.222288	-0.051	0.959	
Participates.to.trainings	0.216638	0.200869	1.079	0.289	

Table 10. Results of OLS regression between droughts and socio-demographic variables.

4. Discussion

The analyses performed on the data obtained by interviewing the villagers in Solevu and Yaro allowed to observe the access and use of water in both the villages, as well as their perceptions of climate change on the island in the past 30 years.

First of all, interviews were conducted by going from house to house and it was decided by the team to interview one house and skip the two following ones, to try to obtain results that varied as much as possible. Even though the aim was to interviewee a similar number of women and men, the majority of the interviewees were women. This unbalance could be because women tend to stay at home during the day to take care of the household duties and look after the children. On the other hand, men usually go to the fields or to the resorts to work during daytime and return in the evening. Indeed, as the interviews were conducted in the morning, more women were found available to be interviewed. Moreover, women are generally the ones in charge of the water use for the household, which makes them more aware of the changes that might have been experienced in relation to water due to climate change.

Among the interviewees, most of them belonged to the age range between 30 and 45. Overall, the age average was 43.6 (and the median 42.5), whereas the average age of females was 44.7 compared to 41.4 for males. The female median age was 43; on the other hand, male median age was 37.5. In fact, the population in the island is mainly composed of young villagers: only a small percentage of participants (20%) was older than 60. Women tend to get pregnant at an early age in Fiji, and life expectancy is around 70 years old.

In both Solevu and Yaro, the majority of the population is married, with a few de facto couples. Marriage is considered to be a very important practice in the Fijian culture; therefore, Fijians get married at an early age. Divorce is very rare, especially for religious reasons.

Work opportunities on the island are predominantly related to the presence of resorts, which give the villagers various types of jobs – from cleaning to security to plumbing. Nevertheless, in both villages the majority of inhabitants were unemployed, meaning that the resorts cannot provide enough job opportunities. As a consequence, many of the people interviewed (32%) declared relying on a relative's salary instead of having their own income. This, especially for women, leads to a lack of independence of the individual. To compensate, women usually produce handicrafts to sell on the beach to tourists, or in other cases they catch and sell crabs.

The distribution of gender roles in the villages varies from household to household. In all the 40 interviews conducted (with 26 females and 14 males), only one household[26] stated sharing the decision-making process between men and women. For the rest, most of the households were male headed, revealing a strong sense of men's power over women. The latter explained that, even though there is a group where women can meet and discuss, their problems are not taken into consideration by men, who make decisions without considering their inputs. Women were found performing a larger part of the domestic chores; however, in households were

[26] Sol_a_05 in the original database

women had a job outside their home, men were found securing water for the household needs, taking care of children, or assisting in other domestic tasks usually assigned as a woman's responsibility. Women in these two rural villages must also adapt to social norms- such as the obligation to cover their legs, to avoid covering their heads and not wearing sunglasses- which are not valid for men.

The analyses revealed the strong reliance of the villagers on rainwater, especially for drinking purposes, and on groundwater for other uses such as bathing, doing the laundry and cleaning. A small percentage revealed also relying on water cartages during shortages; nevertheless, these are often irregular as the Government first takes care of the remoter islands. Comparing this result with the general sources of water in Fiji, it was found that in the country the principal source of water in the larger high islands is surface water, whereas small low-lying islands rely on rainwater and groundwater (WHO, 2016), as observed in the villages. However, the larger islands are also characterised by significant groundwater deposits, such as the Nadi Valley coastal aquifer (Pacific Community, 2007). Rainwater tanks are well distributed throughout the villages, however the water infrastructure that is present needs maintenance and renovating processes. In fact, some interviewees reported about the infrastructure being old and full of leakages[27] and the villagers don't have the necessary skills for the repairs needed. For example, this inadequate infrastructure leads to a greater challenge of the inhabitants of the villages who live close to the shore to receive water during the dry season. Leakages and bursts in the reticulation system are often present also on the mainland, as well as water pressure problems, leading to the necessity of updated equipment and adequate trainings in the Public Works Department (Pacific Community, 2007). Compounding factors to water scarcity and water quality issues are the increasing population both in rural and urban areas, as well as rapid urbanisation in the cities, meaning rising demands of water. Moreover, even though urban migration has increased, many informal and unplanned settlements with no basic infrastructure are present in Fiji, leaving a gap in reticulation coverage. In the country there are approximately 200 informal settlements, which host about 15% of the population (MHMS, 2020). Rural areas often experience the same issues as remote islands, as they have decentralised water infrastructure and receive less water. In addition, the tourism industry, very present on the islands (including Malolo), pollutes water sources through its wastewater (Gibson et al. 2021).

Water withdrawal on the island of Malolo is mostly for domestic use – from cleaning to bathing to doing the laundry- whereas in the main islands -in 2013- 61% of the freshwater withdrawals were for agriculture (compared to 71% in the world), 11% were for industry (compared to 18%) and 28% were for domestic use (compared to 12%) (MHMS, 2018).

When examining the percentage of interviewees having a water tank divided by type of household (meaning male or female headed), it was observed that the vast majority of households with tanks are male headed. This is probably due to the greater presence of male headed households in the sample. In addition, female headed households could be more likely to lack a water tank as they might not have the resources to buy one.

[27] For example, Sol_a_05 and Sol_b_03

Water is available throughout the year apart from the dry season, in which interviewees stated facing concerning water shortages and water quality problems mostly caused by dirt accumulation, debris and salt. As water is rationed and the community boreholes are opened only twice a week, rainwater harvesting is essential to meet the water needs of the families. Comparing the two villages, Yaro has a greater water coverage due to its smaller population and better infrastructure. During dry periods, a consequence can be the part-time closure of the school in Solevu, which then remains open only during the morning. Being the only school on the island, this heavily impacts children's education. Moreover, women declared having a bigger workload during these periods since extra time is needed to fetch water from shared wells.

As a matter of fact, more women than men in both Solevu and Yaro stated facing water shortages and experiencing water quality problems. This could be due to the majority of women among the interviewees, and also to the greater burden that women have in water access and management in the household.

In fact, the different needs and priorities of women and men can lead to gendered deprivation of water. The Individual Deprivation Measure shows a statistically significant difference between men and women in terms of frequency of having enough water in a sample of 2966 individuals (1481 men and 1485 women) from 1125 households from Fiji. Women were more likely to report that they do not have sufficient water to meet their personal needs, as they are primarily responsible for cooking, cleaning, and washing. Figure 49 shows the percentage of men and women stating the frequency with which they have enough water to satisfy their personal needs. It can be observed how men are more likely to report that they 'always' (57%) and 'often' (12.5%) have enough water, whereas for women the percentages were 52% for 'always' having enough water and 11% for the 'often' category. Moreover, double the percentage of women reported 'rarely' having enough water compared to men (12.2% compared to 6.1); nevertheless, 4% of men reported 'never' having enough water, compared to 3% stated by women (Fisk, 2017).

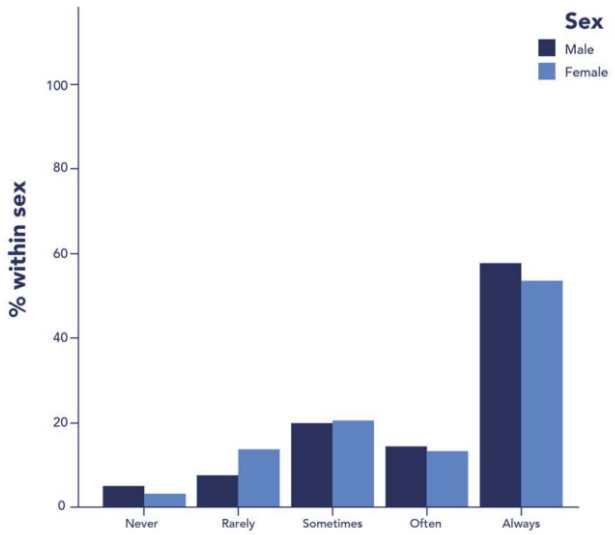

Figure 49. Frequency of having enough water by sex in 2017. Accessed at: https://iwda.org.au/assets/files/IDM-Fiji-Final-Study-Report-31072017.pdf

Even though gendered roles and responsibilities are present, in Fiji -according to the Multiple Indicator Cluster Survey- the people usually collecting drinking water are men over the age of 15 (40%), followed by women over the age of 15 (20%). The percentage of female children under the age of 15 collecting water (5%) instead, is more than double the percentage of male children the same age (2%). 33% are missing or members do not collect (Fiji Bureau of Statistics, 2022a). In Solevu and Yaro, water collection was observed to be shared by women and men, mostly adults.

Regarding the types of toilets used, the most common ones were flush toilets (72%), followed by water seal (25%) and pit toilets (5%). No composting or open defecation is practiced, differently from other remote islands in Fiji, which could be a consequence of the influence of the resorts on the island, where many villagers work and may apply the same practices at their houses. The interviews conducted revealed that on the island the families that participated in the survey only had one toilet in their household. However, the Individual Deprivation Measure concerning Fiji (Fisk, 2017) shows that more than twice the number of men compared to women (810 men vs. 323 women) have access to a secondary toilet, and of those with access to it, 34% of men and 15% of women have access to a private flush secondary toilet. This could be due to more women working from home and thus not requiring a secondary toilet. Moreover, more men than women use a public flush toilet and men reported being able to use a bush/field/river as a secondary toilet (15%) compared to 0.4% of women who use a secondary toilet.

In the villages serious issues of water contamination were highlighted. For example, contamination was observed to be caused by heavy rain, which makes the water dirty and muddy by transporting soil from around the source into it. Moreover, leaves contaminate the water at the source, as well as animals such as frogs. In addition, saltwater intrusion makes the water salty. Finally, dirt inside the pipes was said to be an additional problem contaminating water. Nevertheless, no waterborne disease was affecting the inhabitants of the village according to the nurse. In all the Republic of Fiji in 2012, the mean number of deaths attributable to inadequate water, sanitation and hygiene in Fiji was 25, with 12 from unsafe water, 3 from unsafe sanitation and 17 related to hygiene (MHMS, 2018). In 2019, the mortality rate attributed to exposure to unsafe WASH services (per 100000 population) was 11.5 for males and 10.1 for females. On the other hand, in the same year the WASH deaths in Fiji were 52 males and 44 females (WHO, 2022). Concerning children, unsafe water, sanitation, and hand washing causes 4.4% of all deaths in children under the age of 5, and 5.5% in the age group 5-14 (MHMS, 2018).

Fiji is one of the most vulnerable nations to climate change and its related disasters. Indeed, the country is exposed to rising sea levels, floods, landslides, and tropical cyclones. The country has ratified the Paris Climate Agreement and submitted its Updated Nationally Determined Contribution. An assessment done by the Government of Fiji together with the World Bank Group and the GFDRR (Global Facility for Disaster Reduction and Recovery) estimated the need for an investment of $9.3 billion by 2027 to increase Fiji's resilience and mitigate climate change (World Bank Group, 2021). Indeed, Fiji ranked 71st out of 182 countries in the 2020 ND-GAIN index, which summarises a country's vulnerability to climate change in combination

with its readiness to improve resilience[28]. According to the index, Fiji is the 87th most vulnerable country and the 66th most ready country, meaning that the country has a relatively low vulnerability score and a high readiness score. Nevertheless, the correlation between climate change and water variability are not often well understood in both Solevu and Yaro, as it is difficult to associate some consequences of climate variability to normal weather conditions or to changes in climate. Interviewees oftentimes expressed that the changes they have been noticing in water availability and quality are due to normal weather conditions, associated with variability. For example, the same percentage of villagers stated experiencing "more water" than "less water" nowadays compared to the past 30 years, even though some of the water sources on the island are being reduced by rising temperatures and sea level rise. In addition, people who declared experiencing "worse quality" of water now often referred to causes such as the increase of animals on the island or burning practices near the water sources. On the other hand, some of the villagers have shown to be aware of climate change and its consequences and expressed their concerns regarding the future of their island[29] and their quality of life in the future. Despite this confusion, the vast majority of interviewees (89%) reported believing that there is a relationship between the changes in climate and the changes in water, and most of the interviewees (59%) chose the option "climate change" instead of "normal weather patterns" when asked what the cause of changes in water bodies in their opinion was. Despite this, many interviewees choosing "climate change"- added that they thought the causes were mostly due to compounding factors (such as population and animal increase) and not strictly related to climate change. This reinforces even more the hypothesis that the understanding of climate change on the island is limited.

Nevertheless, the analyses performed on the data obtained from the perceptions of the villagers on the increase, decrease or no change of climatic variables revealed that, in most cases, their perceptions were accurate with the meteorological data. Indeed, interviewees have stated experiencing increases in temperature, frequency of cyclones, frequency of droughts, and sea level rise, which are in line with the trends apparent in historical meteorological data. In the case of tropical cyclone frequency, a large percentage of interviewees expressed having experienced a decrease in its frequency. This could be due to the fact that cyclones were registered in all the Republic of Fiji, including therefore more areas than the one considered in this research project, as the island does not dispose of a weather station; moreover, the interviewees mostly recall cyclones of a certain entity, such as Cyclone Winston in 2016. For the other variables, there was discordance between the perceptions and the actual trend: this was the case of rainfall and frequency of floods. In the first case, interviewees reported having noticed a decrease in rainfall, whereas meteorological data shows an increase in the past 30 years; in the case of floods, instead, villagers stated having observed no change at all in floods, whereas floods have been increasing in Fiji since the 1990s. These inaccuracies could be due to the fact that, for example in the first case, rainfall is strongly influenced by El Niño, which makes rainfall events very variable. The perception of the villagers regarding rainfall could be therefore biased and confused. Moreover, interviewees tended to answer "decrease" because the drought periods have become longer, therefore Fiji is

[28] https://gain.nd.edu/our-work/country-index/rankings/
[29] For example, Sol_a_07

experiencing reduced wet periods and rainfall is concentrated mostly in extreme events. As for floods, the issue could be that the data was collected by the Fiji Meteorological Service for all the archipelago, and not specifically for Malolo Island. Moreover, data from the past 15 years is still missing, hence not giving a clear idea of the trend. Nevertheless, a significant percentage of interviewees (36%) also stated having observed an increase in floods, in line with the actual trend.

Most of the meteorological variables analysed did not show correlations with the chosen socio-demographic variables (age, gender, type of household, participation to water committees and participation to trainings). However, a few (negative) correlations were present when analysing cyclone frequency, floods and sea level and the socio-demographic variables of gender and the participation in water committees. These correlations, particularly with the latter, could seem contra intuitive as it would be expected for people who participate to the water committee to be more informed and more aware of climate change. In addition, women resulted being less likely than men to state that the meteorological variables have increased. It would be interesting, in future studies, to analyse more in detail the reasons that lead to these results. However, it must be highlighted that the low sample size also influences the statistical significance of the analyses, making it harder to obtain significant results. Moreover, the percentage of people participating in water committees is quite low, which could affect the results. It is also important to specify that these are not causal effects but simple correlations between variables.

Some of the interviewees reported being worried about the future of their island[30]; research shows that considering data obtained from the CMIP5 model used in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) and taking into account four different Representative Concentration Pathways (RCP2.6, RCP4.5, RCP6.0, and RCP8.5), it is observed that by 2100 there will be a consistent warming, which however changes depending on the scenario. Rainfall projections are less certain, and trends indicate that average annual rainfall may not vary, whereas there will be an increase in the intensity of extreme rainfall events.

Projected temperature rises are similar to the global average, with a 2.7°C average projected by the end of the century (under the highest emissions pathway, RCP8.5), compared to the global average of 3.7°C. Seasonality is also observed in the projected temperature rises, concerning the warmest months - January to April (Fig. 50) (World Bank Group, 2021).

[30] For example, Sol_a_07

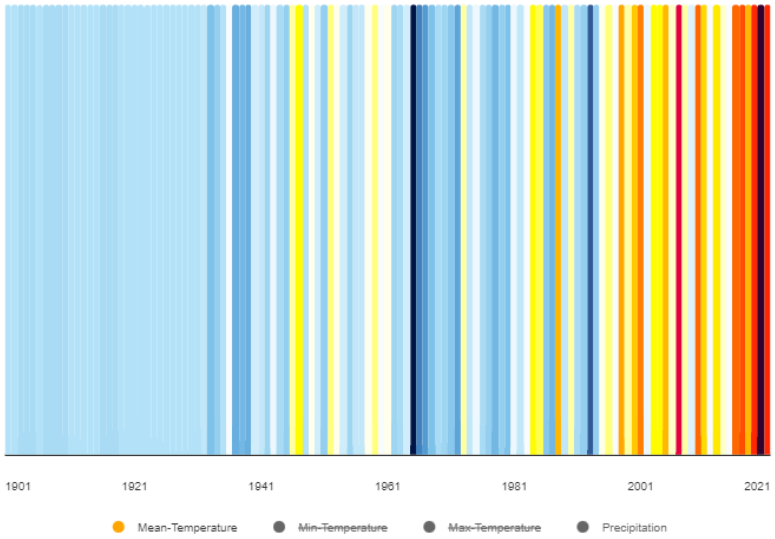

Figure 50. Observed annual mean temperature in Fiji between 1901-2021. Accessed at: https://climateknowledgeportal.worldbank.org/country/fiji

Significant increases are also projected for heat weaves, defined as a period of 3 or more days where the daily temperature is above the long-term 95th percentile of daily mean temperature, which will occur under all emission pathways (World Bank Group, 2021). Women are more impacted than men by extreme heat waves and wildfire smoke, as these phenomena increase the risk of premature birth and lead to increased hospitalisation of young children, with relevant effects on women.

As for precipitation, there is higher uncertainty since future precipitations will also depend on potential changes to the El Niño system. However, models suggest an increase in the frequency and intensity of extreme rainfall events (World Bank Group, 2021). Very extreme events, meaning rainfall of more than 200mm are projected to become less frequent in the near-term future; however, extreme events with more than 50mm of rain will increase. The number of extreme rainfall days is projected to increase in the long-term, nevertheless there is little agreement on the magnitude of the expected change. In addition, while rainfall events are projected to increase in intensity, a decrease in frequency of maximum daily rainfall of over 200mm is expected to continue until 2100 (Kapoor et al, 2021).

Tropical cyclones usually occur multiple times a year, especially between November and April, however they are less frequent during El Niño periods. Their effects can be either direct or indirect and commonly include loss of life and economic damage. In fact, cyclones cost around 5% of the GDP of the country every year.

In 2016, tropical Cyclone Winston affected 62% of the population of Fiji. After the cyclone, 250,000 people were left without access to safe water, sanitation and hygiene services, having to rely on unsafe water sources. In fact, rainwater harvesting systems were damaged due to destruction of roofs, gutters and storage tanks. Moreover, access to sanitation facilities has been affected due to destruction of toilets, potential flooding of pits and lack of water for flush toilets. In addition, displaced families in evacuation centres do not have access to basic hygiene materials (OCHA, 2016). Despite affecting the population with no significant gender differences in deaths or injuries thanks to efficient early warning systems, the impact at the economic level

was much heavier for women, especially in remote areas. In fact, the destruction of their homes and raw materials had a significant effect on women with home-based livelihoods (such as mat and basket weaving); moreover, women do not dispose of protection from insurance or access to finance and loans, thus limiting their opportunities for income diversification. Many women were also impacted by the destruction of sand crab habitats, where they used to engage in small-scale fisheries, and of coconuts, which they used to sell. Therefore, women in Fiji are more likely to be economically impacted than men by disasters due to their low incomes and extensive engagement in the informal sector, thus increasing their economic dependence on men after such disasters.

Cyclones are also associated to floods and storm surges. Flooding is correlated with La Niña periods and is usually driven by heavy and prolonged precipitation that causes surface and river flooding. Climate change risks include the effect of sea level rise in enhancing the damage caused by phenomena such as floods and storm surges, as well as an increase in the extent of fluvial floods of 13% by 2050 and 19% by 2100 (World Bank Group, 2021). These events disproportionately affect women as they result in an increasing dependency of women on subsistence economic activity and deepening their poverty (PINA, 2016).

With Malolo being an island, as it has been perceived by the interviewees it is heavily subjected to sea level rise. Indeed, coastal zones are highly exposed to the risks of climate change, especially due to the related sea level rise, which is expected to be in the range of 0.44-0.74 meters by the end of the 21st century (World Bank Group, 2021). The estimate could increase up to 1.84 m if also considering the Antarctic ice-sheet loss. Given Fiji's extensive coastline, the country is deeply exposed to sea-level rise, erosion, and saltwater intrusion, especially concerning the low-lying islands. The nation's vulnerability has been increased by human development, such as the clearing of mangroves, which normally act as a natural barrier to erosion and inundation. Fiji is also subjected to tsunamis, generating floodings, which will worsen due to sea level rise (World Bank Group, 2021). Sea level rise directly affects freshwater availability, by contaminating groundwater sources with salt and making it not suitable for drinking, cooking or washing. As the villagers strongly rely on groundwater, this kind of contamination strongly affects their daily lives by having to rely more on rainwater, which can be scarce during dry periods.

Another natural resource threatened by climate change includes coral reefs and the respective fisheries associated to these ecosystems. Indeed, ocean acidification due to the increase of atmospheric CO_2, together with the increase of temperature and various human activities will cause the decline of coral reefs both in health and extent since these islands will not present any more suitable conditions for the corals to survive and thrive. As a consequence, biodiversity will be reduced and along with it the fisheries that depend on this biodiversity will be affected, impacting the livelihoods and food security of many people. Tourism and other cultural services that are crucial to local communities will also suffer from this decay (World Bank Group, 2021).

Climate change is already having an impact on agricultural production on the island. Villagers have perceived a difference in the quantity and size of their crops, which have reduced. In fact, the impact of climate change

on agriculture and food production in Fiji will be direct and indirect. In the first case, it will include alterations to carbon dioxide availability, precipitation, and temperature. On the other hand, indirect effects are represented by impacts on water resource availability and seasonality, soil erosion, changes in pest profiles, the arrival of invasive species and desertification. Furthermore, increased intensity and frequency of storms- to which Fiji is subjected- will cause damage to crops. Fiji has mostly shifted towards large-scale, high-intensity farming; however, smaller farming persists in some islands and is likely to be the least resilient to the effects of climate change due to the limited adaptive capacity. The main crops grown in the country are coconut, sugarcane, and root crops, on which the islanders heavily rely. The increase of extreme events, such as droughts, extreme rainfall and heat waves will particularly affect these crops (World Bank Group, 2021).

The country's economy heavily relies on tourism. Nevertheless, this sector will be affected by climate change, both directly and indirectly. For example, rising sea levels and coastal erosion will reduce the quantity and quality of available beach space, if adaptation measures are not installed. Furthermore, the increased intensity of extreme weather events could impact the infrastructures and discourage potential visitors (World Bank Group, 2021). Given that a large percentage of villagers work in touristic resorts, the decline in tourism will directly and heavily affect their primary sources of income.

Mitigation and adaptation are the two main types of response to climate change. Women play an active role in adaptation, especially in rural communities, for example by practicing rainwater harvesting for household and agricultural use. Other adaptation strategies in response to predicted reef destruction include turning to freshwater aquaculture and ocean-based tuna fishing instead of coral reef stocks. Indeed, these changes require new trainings, resources, and equipment for women (ADB, 2022). To increase food security, women also make flour by drying cassava (root crop) and breadfruit (fruit) which are commonly found in Fiji to replace wheat flour, as it is quite expensive. Furthermore, based on their local knowledge, women are replacing vegetables with wild yam and sweet potatoes as they grow throughout the year (Charan et al, 2016). Another response to climate change disasters is relocation; however, women are not included in community decision making related to these displacements and have no choice in the process (ADB, 2022). In Fiji, women are also more likely to ask friends and family for assistance and help or to pursue government assistance as it is harder for them to find other financial strategies to cope, such as accessing loans, due to gender bias within credit institutions against women. Besides, social expectations require them to take care of the household and its members, and to collect food and water which limits their time availability to engage in additional paid work. On the other hand, men tend to use their savings, find additional work or migrate as coping strategies. They are also more likely than women to turn to alcohol to cope with the pressure and challenges generated by climate change related disasters (Dudley et al, 2023).

The villagers of Solevu and Yaro have developed their own practical ways of coping with the effects of climate change registered on the island. For example, they:

- build "Bure", traditional cement houses that maintain a cooler temperature inside compared to the wooden houses, as they tend to stay inside during heatwaves;

- build shelters on the shore to exploit the breeze;
- listen to the radio and access internet for early warning statements;
- relocate houses away from the shore to protect them from sea level rise;
- move to high allocated places such as hills during heavy rains;
- purchase root crops from the mainland as droughts affect productivity;
- exploit solar power;
- plant more trees;
- place heavy materials on the roofs and shutters on the windows during cyclones;
- conserve water wisely;
- bathe in the sea when there is water scarcity;
- place logs and sand bags on the shore to protect from inundation;
- sleep outside when it is too warm; they plant coconut trees along the beach to prevent erosion;
- buy tin food when high intensity rainfall impacts food crops;
- rely on fishing during droughts;
- cooperate with the Mamanuca Environmental Society, for example by attending trainings conducted by the society to raise awareness on climate change;
- cut trees around the house to prevent them from falling during cyclones and also take the tanks out from the roof.

The waste management system reveals the lack of knowledge- due to insufficient information- regarding the environmental and health consequences of burning waste, especially plastic. In 2011, between 0.30 and 0.78 kg of solid waste were generated per person every day in Fiji and disposed in the sea, unused land or streets (MHMS, 2018). In addition, the effects that burying waste has on the contamination of water sources – for example through leachate generated by water percolating through a solid and percolating some of its constituents- were not considered as a problem. Therefore, more awareness raising and trainings are needed on the topic to improve the treatment of waste on the island.

As every village has its own water committee, interviewees were asked if they took part in them. Most of the villagers, however, stated not participating in the water committees. The general low participation could indicate the need for more engagement efforts to involve the villagers in decision making processes concerning water access and use. Water management is therefore handled by a few villagers who take part in the water committee. In the Republic of Fiji, there are 37 government institutions related to water and 8 government ministries involved in water and sanitation services: Waterways and Environment, Lands and mineral resources, Agriculture, Forestry, Health and medical services, iTaukei affairs, Rural and maritime development and disaster management, and Economy. These have a cross-sectoral approach and there are policies and legislations related to water specifying how government departments, NGOs and donors should address water resource management issues (Wilson et al, 2022). Regardless the numerous stakeholders involved in WASH in Fiji, in the case of rural areas the communities are ultimately responsible for their own WASH services, as

observed in Yaro and Solevu. Rural communities in the islands often rely on consistent external support – such as funding for infrastructure, planning and design and management training- to manage their WASH, support which is difficult to provide from governments and civil society organisations (CSOs) due to the remoteness of the communities, the inappropriate technology, and poor land use practices (Drakeford, 2019). Research conducted by the Asia Foundation in collaboration with the Australian Water Partnership (AWP) studied the political economy of the water sector in the Pacific Island countries (PICs) to understand their socioeconomic status and the relative status of water resource management. Key-informant interviews were conducted in 14 countries and a public perceptions survey was performed in Fiji's Nadi River basin to detect community needs and expectations and how they could be addressed more effectively by institutions and organisations. The findings of the study revealed significant differences across the PICs regarding their political economies of water management and use, which need to be taken into account when planning water resources management interventions. Moreover, the perceptions survey conducted in the Nadi River basin revealed a situation similar to the one observed in Malolo island: the communities living along the river rely on ageing piped water supply, boreholes, wells, creeks, and water rationing and often create informal coalitions to collect water in communal tanks. Some of the communities that were identified, for example Solove, Solove Heights, Marasa, Tunalia, Niihau and Waireba, suffer dirty water, low pressure, broken pipes, disconnected reticulation, and intermittent water supply, and only have water delivery every two weeks. These communities have developed a remarkable capacity of resilience due to the irregular supply of water, which could be fundamental to develop strategies to adapt to the challenges posed by climate change. However, the majority of them are far from reaching SDG6 by 2030 and it is indeed necessary that the government makes water resources management a firm priority (The Asia Foundation, 2022).

Therefore, it is necessary to:

- Strengthen the capacity and management skills of government institutions for example by providing training in utility management and environmental monitoring;
- Support the Ministry of Health and Medical Services to strengthen WASH surveillance and sex-disaggregated reporting;
- Advance development of a catchment-based approach for surface water sources;
- Support rural and small island water supply schemes by building community capacity;
- Finance infrastructure upgrades;
- Improve water quality and wastewater quality standards, monitoring and regulatory systems (Wilson et al, 2022).

Among the villagers not participating to the water committees, most of them were women (55%). The latter, if included, were given mostly the role of secretaries due to their nice handwriting. This further shows the lower consideration and participation of women in society, attributing them the sole role of being housekeepers. Despite the numerous stakeholders and organisations involved in water related management in Fiji, women are still underrepresented even though in some communities they hold responsibility for household water and WASH. For example, in 2018, across the Ra and Ba provinces, their representation on community

water committees was only around 21%. A project led by Australia Water for Women has worked between 2018 and 2022 to improve this situation in 18 communities and 11 schools across the two provinces and obtained significant progress. In fact, the percentage of women on WASH committees increased to 41%, with women being elected to six water committees that previously had none. A wider acceptance and support of women in leadership roles from male leaders was also highlighted (Water for Women, 2023).

Even when exploring the participation of the villagers to trainings on water management or on women emancipation, the majority (75%) declared not having participated, with women stating for example that the reason was that they didn't have time because of work and taking care of children. The small number of participants having attended trainings[31] could reveal a gap in knowledge and skills to address water related challenges in an effective manner. Therefore, it is necessary to implement trainings that are accessible to both women and men, taking into consideration their roles and responsibilities.

Moreover, the lack of awareness on gender equality should be compensated by promoting initiatives incorporating gender equality and addressing gender issues, especially those related to water and sanitation.

The villagers, thanks to the location of the island, maintain a traditional lifestyle. Nevertheless, the vicinity with the resorts and the closeness to the main island are influencing their way of living, especially among the young inhabitants. In fact, many interviewees stated going to the mainland often for shopping or to carry out duties; a small number of villagers also reported having a second house on the mainland. Many of the inhabitants of the villages have family on the mainland, and as kinship is considered a fundamental link between people, these families are based on strong socio-cultural norms of reciprocity and help (Love et al., 2022). These transfers from the mainland to the island represent opportunities to incorporate some of the urban lifestyle in their rural way of living. Moreover, the growing availability of phones and access to internet on the island are accelerating the process of homogenisation of cultures and traditions. On the other hand, many traditional practices -such as sleeping on rugs and eating on the floor- are kept on the island notwithstanding the connections that the villagers have outside their village. For example, even though most of the inhabitants work at the luxury resorts and daily observe a certain way of living, they seem not to be willing to switch to some of the comforts they see in the hotels.

Despite these connections, the island of Malolo is quite isolated in terms of help from the Government and institutions related to water management, such as water infrastructure maintenance or water cartages delivery during periods of drought.

Based on these findings, it is possible to observe that both villages require involvement of entities such as the Government or NGOs to:

- Upgrade and implement the water infrastructure, to ensure equitable access to clean water and improve its quality and availability.

[31] For example, Sol_a_04, Sol_b_06, Sol_b_08, Sol_c_04, Sol_c_05, Yar_a_01, Yar_a_03, Yar_b_03, Yar_b_04

- Implement water resources management that is climate resilient to mitigate the impacts of climate change. For instance, water sources could be more protected to prevent contamination from debris and soil, which is increasing due to more frequent heavy rainfalls and cyclones.
- Apply nature-based solutions to cope with the effects of climate change. For example, seagrass meadows are an important marine ecosystem which are highly abundant in Fiji (Mckenzie, Yoshida, 2020). In addition to supporting biodiversity and improving water quality (McKenzie et al, 2021), these plants can stabilize sediment with their roots and reduce wave energy thanks to their leaves. This leads to a reduced erosion and to a lessening of the impact of extreme events such as tropical cyclones, which are increasing in intensity due to climate change. Seagrasses have been demonstrated to be resilient to cyclone disturbances (Correia, Smee, 2022), therefore, as the environment in Fiji allows their growth, more seagrass meadows could be planted in areas that are more exposed to tropical cyclones to decrease their impact.
- Promote community engagement to trainings and committees for awareness raising and decision making, focusing on involving both men and women. Special attention should be given to gender-responsive training programmes, to promote gender equality in the villages and provide the inhabitants with the skills necessary to address water-related challenges. In addition, awareness campaigns on climate change and water conservation should be launched.
- Waste management should be a priority to address, in order to teach and apply proper waste management practices in both the villages to reduce water contamination and environmental and health issues.

5. Conclusions

The Republic of Fiji is strongly impacted by the effects of climate change, especially in rural areas and in the remote islands such as Malolo Island. Temperatures have been increasing, as well as cyclone intensity; sea level rise is threatening the coastal areas and aquifers; extreme rainfall and floods are destroying crops and droughts are making water shortages and rationing more frequent. Indeed, these impacts have serious consequences on water availability and quality, as water resources can be contaminated by heavy rainfall events or salt intrusion and droughts reduce the quantity of water present at the source. This adds to the already inadequate and old infrastructure on the island, which is full of leakages and needs maintenance.

The inhabitants of the villages of Solevu and Yaro are perceiving these changes and worry about their quality of life in the near future, even though to some extent the villagers believe that these effects are due to normal weather patterns such as seasonality.

Moreover, gender disparities are present in the island, where men are the decision-makers and women are mostly excluded from participating to educational trainings or village committees. These issues are exacerbated by climate change, as women are the primary responsible for water management in the household and have to face the problems of water scarcity and worse water quality beforehand, finding alternative ways of providing water for the household.

It is therefore necessary to provide adequate and specific trainings - to both women and men in the villages - on water management and infrastructure. An implementation of the research project could be the cooperation with the Water Authority of Fiji to perform updating and maintenance works on the existent infrastructure in Solevu and Yaro, as a response to their concerns expressed in the interviews. Another survey could then be developed to be conducted after various years to see if the situation has improved and to assess the satisfaction of the villagers with the new infrastructure; besides observing if climate change is perceived in a more evident manner. In addition, gender equality should be promoted through awareness campaigns.

Furthermore, some of the limits of this research project are the small sample utilised and the unbalance between men and women in the sample, with women being the majority. The former problem creates a difficulty in generating statistically significant results during the analyses. Therefore, a bigger sample with more balance between the sex of the participants could be interviewed in future research. In addition, the project could be upscaled to other Pacific Small Island Development States, which are facing similar problems to Fiji regarding water access and climate change.

In conclusion, this research project highlights the complex interaction of factors affecting water availability and quality, as well as climate change and gender dynamics. In order to address these challenges, a holistic approach is needed, which takes into consideration the entirety of the community.

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Annexes

Annex I – Training agenda

SCHEDULE (local time)	**Sunday, 09 July 2023**
Afternoon	Coordination with local focal points from Water Authority of Fiji and Fiji Meteorological Service
SCHEDULE (local time)	Monday, 10 July 2023
08:30-09:00	Registration of participants
09:00-09:30	• Welcoming messages o Fiji Meteorological Service – Acting Director o Water Authority of Fiji - CEOW o UNESCO WWAP – Ms. Laura Imburgia, Senior Water and Gender Specialist, UNESCO WWAP • Tour-de-Table with participants
09:30-10:30	Introduction to the workshop and field work project 1. Water and Gender: basic concepts and frameworks
10:30-11:00	Tea and Coffee Break
11:00-12:00	UNESCO WWAP Water and gender approach 2. Sex-disaggregated water data and gender indicators 3a. UNESCO WWAP Water and Gender Toolkit
12:00-12:30	Group exercise: Applying the WWAP Indicators & Toolkit for developing study instruments (1) – Use of the Toolkit for selecting priority topics and indicators
12:30-13:30	Lunch Break
13:30 -14:30	3b. UNESCO WWAP Gender-responsive indicators
14:30-15:30	4. Guidance for 'water and gender' data surveys Group exercise: Applying the WWAP Indicators & Toolkit for field work (2) – Developing the questionnaire

15:30-16:00	Tea and Coffee Break
16:00-16:30	Group exercise reporting and discussion
SCHEDULE (local time)	Tuesday, 11 July 2023
09:00-10:30	Preparation of field work: revision of the study instruments, survey and interviews
10:30-11:00	Tea and Coffee Break
11:00-12:00	5. Water and gender data entry and analysis Group exercise: Applying the WWAP Indicators & Toolkit for data analysis (3) – Preparation of the pilot database and analysis
12:00-13:00	6. From data to information to policy – how pilot findings will be used? Group discussion
13:00-14:00	Lunch Break
14:00-14:45	7. Water and climate considerations and how these may affect women and men differently – Fiji Meteorological Service/WWAP
14:45-15:45	Organization of logistics for the fieldwork
15:45-16:15	Tea and Coffee Break
16:15-16:45	Closure of the workshop and delivery of certificates
17:00 – 20:00	Organization of logistics for the fieldwork – relocation of the field work from Viwa Island to Malolo Islands
SCHEDULE (local time)	Wednesday, 12 July – Saturday, 15 July 2023
Morning	Trip from Nadi to Solevu village, Malolo island
Afternoon	Visit of the village, overview of survey with the team and test of the survey

SCHEDULE (local time)	Thursday, 13 July, 2023
Morning	Conducted surveys in Solevu village
Afternoon	Conducted in-depth inteviews in Solevu village
SCHEDULE (local time)	Friday, 14 July, 2023
Morning	Conducted surveys in Yaro village, including key informants
Afternoon	Discussion of results and comparison of the two villages. Interviews in Solevu village
SCHEDULE (local time)	Saturday, 15 July, 2023
Morning	Conducted final surveys in Solevu village
Afternoon	In-depth debriefing among team members and discussion of potential scale up of the project
SCHEDULE (local time)	Sunday, 16 July, 2023
Morning/ afternoon	Trip from Solevu village to Nadi
SCHEDULE (local time)	Monday, 17 July 2023
Morning/ afternoon	Field work debriefing and data analysis and reporting coordination

Annex II - Questionnaire

Questionnaire for Malolo Pilot Project

Note: Talk to F/M members of the household separately, if possible

Date: _____/___/___ **CODE OF SURVEY: _____**

1. **Village**: _____
2. **Name of interviewer**: _____
3. **Name of interviewee**: _____
4. **Gender**: _____
5. **Age**: _____
6. **Place of birth**:_____
7. **Years living in the village**:_____
8. **Occupation**: employed – self-employed – unemployed *(circle)*
9. **Your main source of income:**

   _____
10. **Other sources of income:**

    _____

11. **Are you** single - married/de-facto– divorced – widowed? (*circle*)
12. **Who is the head of the household?** (*circle*)
    Yourself – Your partner – Both – Other *(please mention)* _____
13. How many people live in your home? _____

14. Who else lives in your household?

#	Relationship to you (spouse, children, parents, siblings, other)	Male	Female	Age	Marital status	Level of education	Employment status	(if employed) Occupation
1								
2								
3								

4								
5								
6								
7								
8								

Marital status: 1) Married, 2) Single, 3) Divorced, 4) Widowed.
Level of education: 1) None, 2) Primary, 3) Secondary, 4) Tertiary.
Employment status: 1) employed, 2) self-employed, 3) Unemployed.

Note for interviewer: please write below any piece of information about the household that you think it is important and was not asked

Water access and use *(please tick the response/s)*

14.1 Do you have a water source at home?

a) Yes
b) No

(a) If yes, what are the main sources?

You can select multiple choices

- Rainwater
- Groundwater (well)
- Water cartage (Distributed by government)
- Other:_____

(b) If not, where do you get water for your household uses?

_____

(c) Which borehole are you connected to?

- First
- Second
- Both
- Not connected

14.2 What are your main uses of water?

You can select multiple choices

- Drinking
- Cooking
- Bathing (personal hygiene)

- Laundry
- Irrigating /watering plants
- For the livestock
- Other: _____

14.3 Do you face water shortages?

a) Yes
b) No

14.4 If yes, which problems do you have? *You can select multiple choices*

- Not enough water for daily needs (e.g., drinking, bathing, cooking)
- Limited access to clean water sources in the village
- Periodic water shortages or rationing
- Drought conditions impacting water availability
- Inadequate water infrastructure and distribution systems
- Other_____

14.5 Do you face water problems regarding water quality?

a) Yes
b) No

14.6 If yes, which ones of the following? *You can select multiple choices*

- Contamination of water sources
  - Caused by_____
- Waterborne diseases or health risks
- Poor sanitation systems
- Issues with water treatment and filtration methods, for example, desalination
- Other_____

14.7 What kind of water treatments do you use?

- No treatment – we use it directly
- Boiling
- Chlorine tablets
- Other:

14.8 What are some water conservation methods you or your family members practice daily/weekly?

Enumerator: wait for answer, do not read aloud response options

- Limiting amount of buckets freshwater per bath
- Having sea bathing only

- Collecting and storing rainwater for non-potable uses
- Reducing the amount of water used in the toilet
- Collecting and reusing graywater for non-potable uses
- Educating family members about the importance of water conservation
- Participating in local water conservation campaigns
- Other: _____

14.9 Do you have a water tank at home?

a) Yes
b) No

14.10 if yes, did you receive it from WAF?

a) Yes
b) No

14.11 Who did you receive it from? _____

14.12 if yes, what is the size of your tank? _____litres

14.13 Do you reuse grey water?

a) Yes
b) No

14.14 If yes, how?

Sanitation & Hygiene

15. What kind of toilets do you use at home?

You can select multiple choices

- Flush
- Water seal
- Pit toilet
- Composting toilet
- Bush toilet (open defecation)

Climate Change

16.1 What changes have you noticed regarding sources of water over the past 10 years?

- We have **more** water than 10 years ago
- We have **less** water than 10 years ago

- Our water is of **better quality** than 10 years ago
- Our water is of **worse quality** than 10 years ago
- Other: _____

16.2 Do you think there is a relation between the changes in climate or weather conditions and the changes in the water you access?

a) Yes
b) No

Please explain.

16.3 Please, describe how the changes in water quantity and/or quality have affected the availability of water for household / domestic needs for different household members.

Sex	Age	Position in household	Impacts

Sex: 1)Female, 2) Male, 3) prefer not to respond

Note for interviewer: please write below any remark from respondent that you think it is important for this topic

16. 4 What changes have you noticed about water bodies over the past 10 years? (wells)

You can select multiple choices

- More algal blooms
- Increased saltwater intrusion

- Lowering of water table
- Other _____

16.5 According to you, what are the causes of these changes (in water sources over the past 10 years)?

Enumerator: wait for answer, do not read aloud response options

- Climate change
- Normal weather patterns
- Other: _____

16.6 Are there more people migrating from Malolo?

	Female	Male	If yes, why do people migrate?		
			Better education	Work opportunities	Water issues
Yes					
No					
Not sure					

16.7 Are people coming to live to Malolo from urban areas?

a) Yes
b) No

Please explain the reason for your response:

16.8 Have you noticed changes in the following during the last 10 years? *Mark with an X*

Variable	**Increase**	**Decrease**	**No change**
Temperature			
Rainfall			
Changes in your crops			
Intensity of cyclones			
Frequency of cyclones			
Droughts			

Floods			
Sea level			
Other (_____)			

16.9 How are you managing the changes mentioned in the previous question (13.8). *Interviewer: please provide some examples*

Governance

17.1 Do you participate in community water committees?

a) Yes
b) No

17.2 If yes, do you have a position?

a) chairperson
b) secretary
c) treasurer
d) member with no specific role
e) other: _____

Education/Training

18.1 (a) Have you participated to awareness trainings on water tanks uses, rainwater harvesting or similar?

a) Yes
b) No

18.1. (b) Main activities of the training

18.2. if yes, who delivered the training?_____

18.3 If you haven't, please explain the reason.

_____

18.4 Did you receive any financial assistance to complete the training?

a) Yes
b) No

18.5 What kind of assistance did you receive?

18.6 If yes, who did you receive it from?

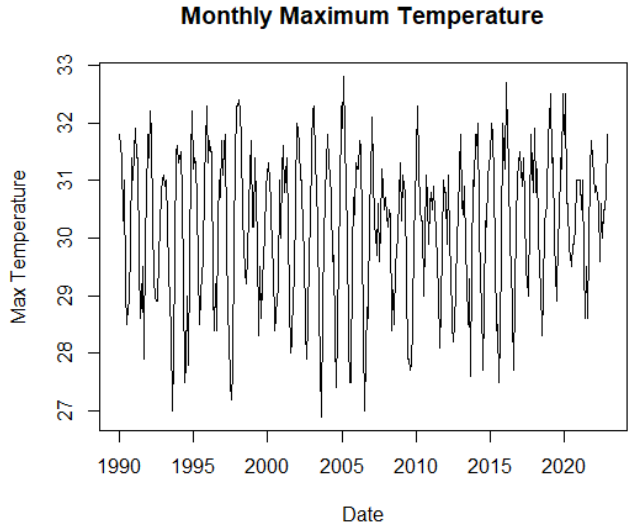
- Government departments
- NGO
- Training institute
- Water committee or your community
- Other: _____

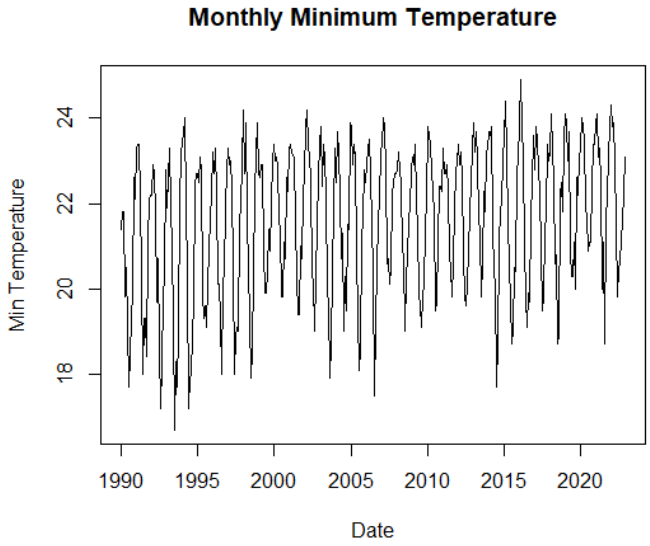
18.7 Do you know any awareness campaign for gender equality related to water?

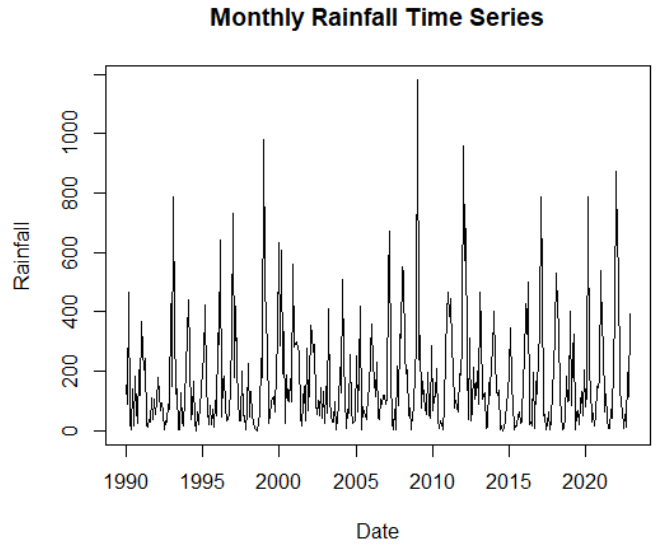
a) Yes
b) No

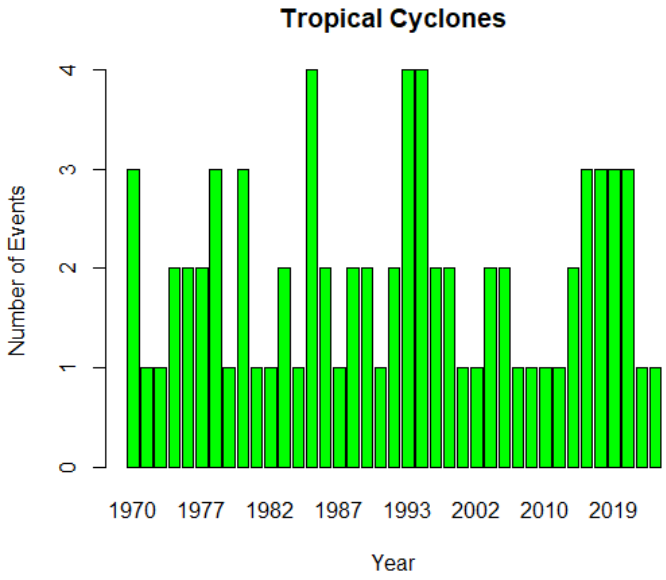
If yes, can you provide details?

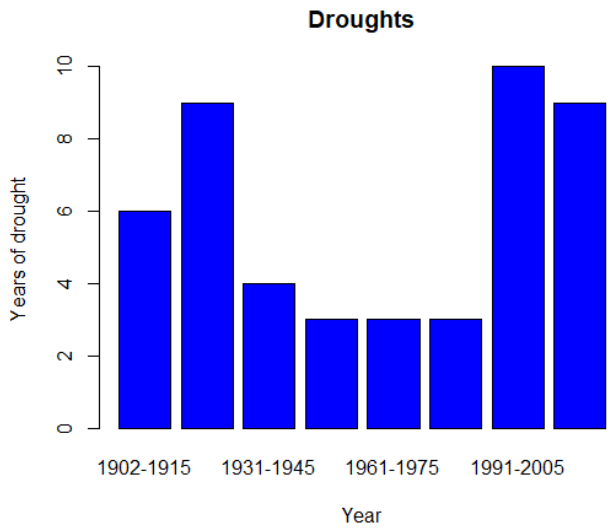
Annex III – original plots of the considered meteorological variables

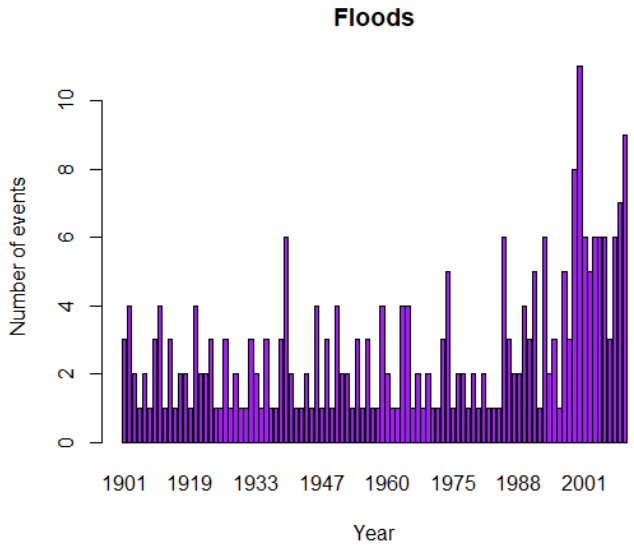


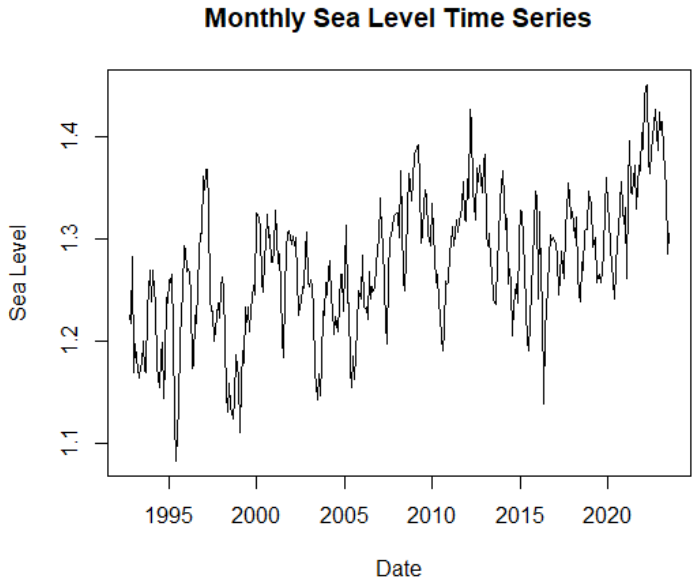



Monthly Rainfall Time Series
Rainfall
0
200
400
600
800
1000
1990
1995
2000
2005
2010
2015
2020
Date


Tropical Cyclones
Number of Events
0
1
2
3
4
1970
1977
1982
1987
1993
2002
2010
2019
Year


Droughts
Years of drought
0
2
4
6
8
10
1902-1915
1931-1945
1961-1975
1991-2005
Year


Floods
Number of events
0
2
4
6
8
10
1901
1919
1933
1947
1960
1975
1988
2001
Year


Monthly Sea Level Time Series
Sea Level
1.1
1.2
1.3
1.4
1995
2000
2005
2010
2015
2020
Date

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