Location – Based Information for Sustainable Development of Forests

Mohammed Abdullah Bin Shorab (2105064)
MSc Environmental Conservation and Management

Supervised By:
Associate Professor Chris House

7th September 2022

DECLARATION

I declare that the work in this dissertation was carried out in accordance with the regulations of the University of Wales Trinity Saint David. The work is original except where indicated by special references in the text and no part of the dissertation has been submitted for any other degree.

Any views expressed in the dissertation are those of the author and in no way represent those of the University of Wales, Trinity Saint David.

The dissertation has not been presented to any other University for examination either in the United Kingdom or overseas.

I hereby give permission for my work, if accepted, to be available for photocopying and inter-library loan, and for the title and summary to be made available to outside organisations.

Signed: *Mohammed Abdullah Bin Shorab*

Date: 07/09/2022

ACKNOWLEDGEMENT

I would like to show my sincere appreciation to Chevening Scholarships, the UK Governments global scholarship program, funded by the Foreign, Commonwealth and Development Office (FCDO) and partner organizations for the opportunity to undertake my studies in the United Kingdom. I would also like to thank the Fijian Government for granting me study leave to undertake this study.

To my teachers, family, and friends who in any way assisted me during my MSc journey and made it a memorable one, this is for you all.

ABSTRACT

It is widely acknowledged that the planet is experiencing anthropogenic induced environmental challenges that needs innovative and coherent decision making to achieve a sustainable future. Location based information has played an important role in sustainable decision-making for decades. The role of this information as an aid for sustainable forest management has been lightly explored by academia, policy makers and politicians. This study has used mixed qualitative methods and a diachronic approach to quantify the role of location-based information as an aid to sustainable forest management using the experience of Fiji. Results show the significance of location-based information to the sustainable management of forests at an operational level and within strategic decision making. Recommendations suggest that human resource management, organisational structures, technological capacity, and coherent documentation are key areas which need attention for an effective and efficient sustainable location-based information system. Successful application of these research findings can not only be applied to sustainable forest management in Fiji but is transferable to other locations and environmental sectors aiming for sustainability.

ACRONYMS

NFMS – National Forest Monitoring System

FRAC – Forest Resource Assessment and Conservation Division

SDSS – Spatial Decision Support Systems

SDI – Spatial Data Infrastructure

GIS – Geographical Information Systems

MCDM – Multi Criteria Decision Making

TABLE OF CONTENTS

Declaration i
Acknowledgement ii
Abstract iii
Acronyms iv
Table of Contents v
List of Figures viii
List of Tables ix
Chapter 1: Introduction 1
1.1 Introduction 2
1.1 Small Island Developing States 4
1.2 Case of Fiji 5
1.3 Relevance of the study 8
1.4 General Aim 9
1.5 Specific Objectives 9
1.5 Conclusion 9
CHAPTER 2: LITERATURE REVIEW 11
2.1 Introduction 12
2.2 Literature Review Methodology 12
2.3 Structure of Literature Review 14
2.4 Sustainable Forest Management (SFM) 15
2.5 Importance of Decision Making for Sustainable Development 16
2.6 Spatial Information for Decision Making 17
2.7 Organization Structure for flow of decision-making information. 21
2.8 Retaining knowledge and skills in organization – future proof – retainer programmes 22
2.9 Spatial Data Infrustructure 23

2.10 Research Gap 24
2.11 Concluding Summary of Literature 25
Chapter 3: Methodological Review 26
3.1 Introduction 27
3.2 Survey 28
3.2.1 Survey Response 31
3.2.2 Identifying the Respondents. 32
3.2.3 Limitations 36
3.3 Semi-Structured In-Depth Interviews 36
3.3.1 Limitations 39
3.4 Study of Documentation, SOPs, and Historical Materials 39
3.4.1 PGRSC Newsletters. 42
3.4.2 Limitations 42
3.5 Study of Existing Location Based Information Systems 43
Limitations: 43
3.4.1 Participant Observation 43
Limitation: 44
3.6 Conclusion 45
Chapter 4: Results and Discussion 46
4.1 Introduction 47
4.3 Usage of Location Based Information 48
4.4 Type of Location Based Information Used 49
4.5 Need for location-based information. 51
4.8 Spatial Information Management Unit 53
4.9 Human Resources 56
4.6 Decentralizing FRAC 58
4.7 NFMS 59
4.10 Analysing Locational Information 61

4.11 Technological Capacity 63

4.12 Conclusion 63

Chapter 5: Recommendations and Conclusion 65

5.1 Introduction 66

5.2 Organizational Structure and Human Resources 66

5.3 IT Infrustructure 67

5.4 Documentation 69

5.5 Model of Recommendations 70

5.5.1 Measuring Implementation of Recommendations 72

5.6 Limitations 74

5.7 Conclusion 74

5.8 Future Studies 76

References 77

Appendix 95

LIST OF FIGURES

Figure 1.1 Forests of Fiji in 2020 (Source: Ministry of Forestry, Fiji)..... 6
Figure 1.2 Operations Divisions of the Ministry..... 7
Figure 1.3 Three different periods that the Ministry of Forestry's spatial information management unit underwent since 1991.....8

Figure 3.1 An excerpt from the scanned copy of NFI 1969 (Source: Ministry of Forestry, 2022) 28
Figure 3.3 Breakdown of when the respondents' started working for the Ministry. 32
Figure 3.4 Breakdown of respondents by the Division they work in..... 33
Figure 3.5 Breakdown of respondents by the Division they have most experience in. 35
Figure 4.1 How frequently is location-based information used in the Ministry. 49
Figure 4.2 Type of location-based information used to aid works of Foresters. 50
Figure 4.3 A map dating back to 1925-1931 found at the Central/Eastern Division Office of the Ministry.....54

Figure 4.4 A map created by the GIS Officer of the Ministry which will be used for Divisional planning of the Western Operations Division.....57
Figure 4.5: NFMS components - Deployment diagram.....60

Figure 4. 6 Officers who attended workshops or training in use of GIS software while being employed by the Ministry.....62

LIST OF TABLES

Table 2.1 Literature search keywords. 14
Table 2.2 Summary of literature findings. 25
Table 3.1 Connectedness of research objectives and information gathered from survey.....30
Table 3.2 Survey identifiers.....30
Table 3.3 Details of Historical material studied.....41
Table 5.1 Model of Recommendations and its priority levels. 71
Table 5.2 Measuring the recommended priority areas. 73
Table 5.3 Objectives and outcomes of this study. 75
Table 5.4 Details of Future studies which could be undertaken..... 76

CHAPTER 1:

INTRODUCTION

1.1 Introduction

Sustainable Development is development that satisfies the requirements of the present without jeopardizing future generations' capacity to satisfy their own needs (Mitlin, 1992; Chichilnisky, 1997; Jabareen, 2008; United Nations, 2015). Sustainable Development Goals (SDGs) is the global pursuit of ecologically, economically, and socially sustainable development (Schmidheiny, 1992; Oladele, 2002; Sullivan et al., 2018; Eisenmenger et al., 2020). Sustainable Forest Management is a key indicator of the 15th sustainable development goal in the 2020 Agenda for Sustainable Development adopted by the United Nations member states in 2015 (Carlsen and Bruggemann, 2022).

Decision making is an essential aspect of sustainable development (Gardner, 1989; Dernbach, 2003; Aras and Crowther, 2009; Waas et al., 2014; Bolis et al., 2017; Dos Santos et al., 2019). Our future and the future of our generations are dependent on the choices we make every day, which turn into decisions (Gardner, 1989; Dernbach, 2003; Bolis et al., 2017). Informed decision-making helps make effective and efficient decisions (Conroy and Peterson, 2013). The decisions that we make for our environment have an indirect impact on other parts of our lives (Goodchild, 1987; Conroy and Peterson, 2013; Liu et al., 2008). It is particularly important that the decisions we make for our environment are well informed through the use of science and all the available information technology (Liu et al., 2008).

Forests form an integral part of our environment and are home to most of the world's terrestrial biodiversity (Food and Agriculture Organization of the United Gordon, 2008; Nations, 2020). The global forest extent was estimated to be approximately 4,128 million hectares in 1990 (University of Melbourne, 2015). However, there has been a gradual decrease in forest extent since then, with the Food and Agriculture Organization of the United Nations (2020) estimating that approximately 420 million hectares of forests were converted to other land

uses between 1990 to 2020. Having the above in mind it is important to note that the global annual rate of forest loss also declined significantly, being sixteen million hectares in the 1990s and down to ten million hectares between the years 2015 to 2020 (Food and Agriculture Organization of the United Nations, 2020). Scientists and academics have not yet given a scientific explanation of the reason for this decline, however, there is a possibility that this is the outcome of good management of the world's forests by realising how important the forests are for the world especially in combatting climate change and human health (Gordon, 2008).

Although the need to protect and conserve natural resources for future generations had long been widely alluded to, the concept of sustainability began to increase in importance at the end of the 1980s (Martin and Diez, 2012). Sample and Sajdo (1996) have cited Heske (1938) to state that the origins of the term 'Sustainable Forest Management' can be found in 18th century Europe. Sustainable Forest Management (SFM) has been given many definitions over the years (Sayer et al., 1997; McDonald and Lane, 2004; Gough et al., 2008; MacDicken et al., 2015; Yamada, 2018), all of which summarises to using forest resources in a manner that sustains it for future generations.

The decisions made for the management of the world's forests range from a forester in the field who plans a reforestation or logging activity right up to the top tier decision-makers who decide on policies and regulations for the world's sustainable development. A key aid to these decision-makers is location-based information such as maps, locational statistics (example; extent of forests, changes in the extent of forest, deforestation rates, afforestation rates), future projections/predictions, and past information (Baskent and Keles, 2005; Modica et al., 2016). Many diverse types of information and maps are derived from analysis using software and locational data from primary and secondary sources.

Studies have shown that making decisions to sustainably manage forests usually relies on spatial information (Varma et al., 2000; Ishtiaque, et al., 2020). Spatial information is defined as information related to a location or any geographic area (Kuhn, 2012). Analysis and visualisation of spatial information can help measure, monitor, report, and verify the status of forest resources. This process is known as Monitoring, Reporting and Verification (MRV). Essential information such as the location of forests, extent of forests, changes in forest extent/area, effects on the immediate environment surrounding the forest, and many others are basic locational information that influences decision-making for sustainable forest management. Global forest MRV models usually find it difficult to apply Small Islands Developing States (SIDS) due to the complex nature of their diverse and unique forest resources (Wilkie, 2002).

1.1 Small Island Developing States

Small island developing states (SIDS) of the world may have difficulty in achieving sustainable development due to their ecological sensitivity and economic vulnerability (Campling and Rosalie, 2006). Climate change remains the most serious threat to the environment and sustainable development in SIDS (Julca and Paddison, 2010; Thomas et al., 2020). Much of the world is aware of SIDS's long-term development problems and obligations and it has been on the global agenda since the 1992 Rio Earth Summit. It is often believed that SIDS are environmentally and economically vulnerable (Agenda 21; UNEP, 1999, a, b, c). Their natural resources are modest, although they have abundant native flora and wildlife. As indicated in Agenda 21, the sustainable development of these islands presents significant planning and implementation difficulties.

Forests contribute considerably to the national economy and international commerce in wood and non-wood forest products for the majority of the bigger

islands (Hansda, 2009). SIDS are well endowed with forests as a group, although the degree of forest cover varies substantially amongst island nations. While the combined forest cover of SIDS is modest in global terms, forests and trees on these islands are critical to the occupants' well-being (Wilkie, 2002). Furthermore, forest resources on numerous islands are of international significance in terms of their function in biological diversity conservation, particularly endemic species, and genetic variety (Burt and Clerk, 1997). Despite differences in size, location, population density, and climatic, geological, and topographic factors, these states have many traits that put specific limits on, but also provide unique possibilities for sustainable forest management.

1.2 Case of Fiji

Fiji, a small island developing state in the South Pacific, has more than 60% of its terrestrial land area covered by forests (Figure 1.1). In Fiji, the Ministry of Forestry is responsible for the Sustainable Management of Forests (Ministry of Forestry, 2021)

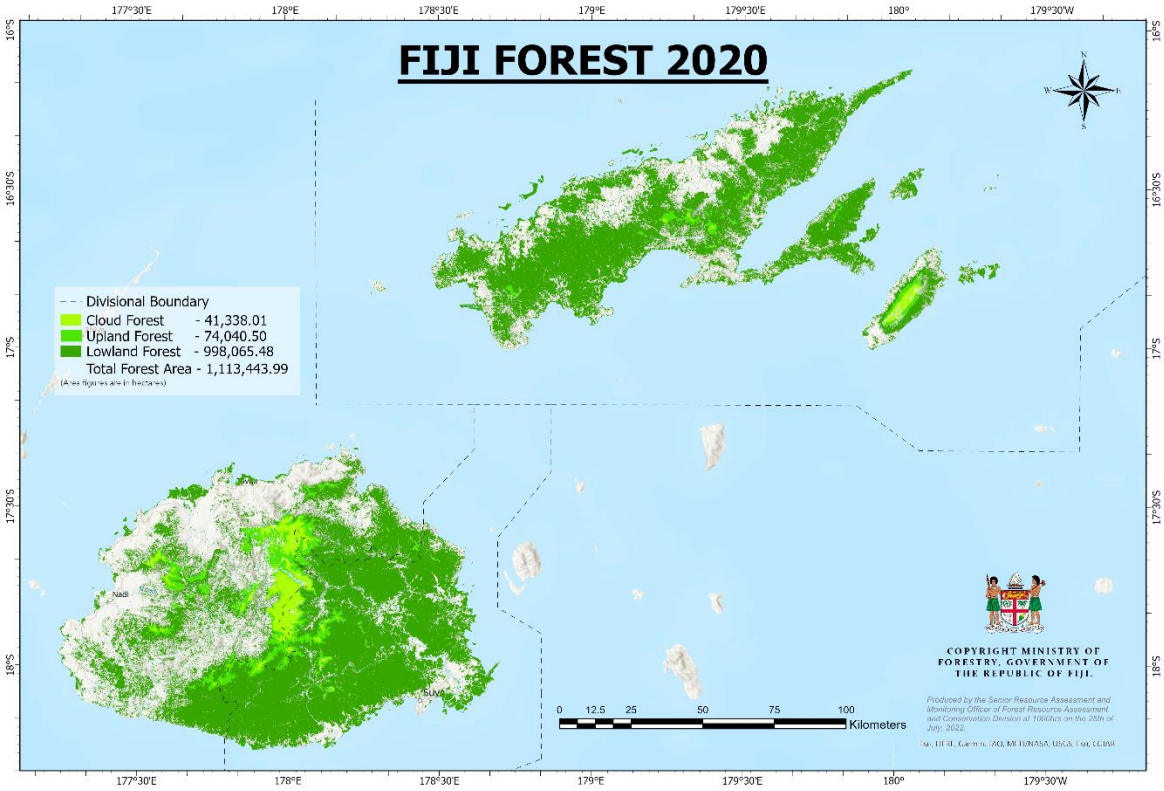


Figure 1. 1 Forests of Fiji in 2020 (Source: Ministry of Forestry, Fiji)

The country has used spatial information for forest-related decision-making for over three decades (Vakacegu, 2015). Delineation of forest area extent and changes in the extent (deforestation/reforestation), different forest types (lowland[1], upland[2], cloud[3], open[4] and closed[5]) have been used for decision making and international reporting. Maps dating back to 1925 can be found in the Ministry archives today, which is evidence of the long relationship between forestry and spatial information. In addition, field-level spatial information on maps has been used to plan harvesting operations, harvest area monitoring, and reforestation planning and monitoring. A unit within the Ministry known as the Forest Resource Assessment and Conservation Division (formerly known

[1] Forests found from sea level to 400m altitude (Mueller-Dombois and Fosberg, 2013).
[2] Forests found between 400m to 600m altitude (Mueller-Dombois and Fosberg, 2013).
[3] Forests found above 800m altitude (Mueller-Dombois and Fosberg, 2013).
[4] Forests having a canopy density of 10% to 40% (Ministry of Forestry, 2020)
[5] Forests having canopy density of more than 40% (Ministry of Forestry, 2020)

as Management Services Division) is responsible for collecting, manipulating, analysing, verifying, reporting, and disseminating Fiji's forest spatial information (Pers. Comm.). The Forest Resource Assessment and Conservation Division operates as a support system and data bank for the three operational Divisions (Map 2) and all other parts of the Ministry.

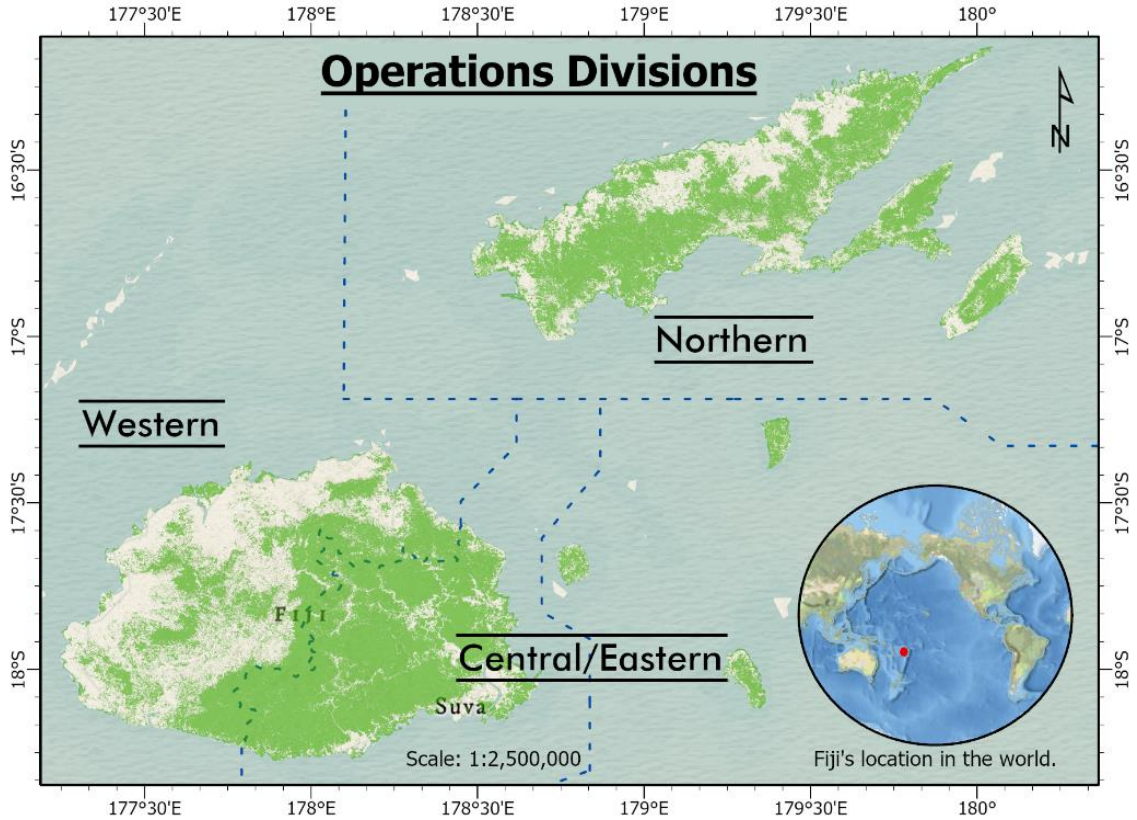


Figure 1. 2 Operations Divisions of the Ministry

Geographical information systems, a system used to store, manipulate, analyse, and present spatial data (Goodchild, 1987), was first set up at this Unit in 1991. This system was set up with assistance from the then GTZ, now known as GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) and was the first of its kind in the Pacific Islands country region (Forstreuter, 2022). It was set up to assist in making effective and efficient decisions for the sustainable management of forest resources using spatial information. This system was operated with the Germans' assistance until the late 1990s, after which the

Fijians took over (Lewai, 2022). From an analysis of publications in the PGRCS Newsletters, spatial information played a crucial role in decision-making for sustainable forest management in Fiji in the 1990s. However, in the 2000s, when the Germans had left, the division struggled in the task. For example, mapping for the National Forest Inventory 2005 took nine years to complete, and the maps were finally published in 2014. In late 2018 the Ministry recruited a qualified GIS officer who established web mapping systems and advanced information systems to provide spatial information. In 2019 the Ministry transitioned to a more digital approach for disseminating spatial information and started using dynamic web maps for the provision/visualisation of real-time spatial information for decision-making in place of static maps.

Figure 1.3 Three different periods that the Ministry of Forestry's spatial information management unit underwent since 1991 (Developed by the author from Wolf, 2022, Pers. Comm.; Lewai, 2022, Pers. Comm.; Anonymous, , 2022, Pers. Comm.).

Keeping time constraints in mind, this study will only focus on the Ministry of Forestry in Fiji. Although other stakeholders have a role in the Forestry industry of Fiji but as earlier stated, the Ministry is responsible and leads the protection, conservation, management, and sustainable development of Forests.

1.3 Relevance of the study

The outcomes of this study may influence policy and planning for proper administration and operation of spatial information management units in small developing states. It can also provide a basis for investment into spatial information systems by giving an insight into the importance of spatial information for the overall decision-making process and the sustainable

management of forests. The study also provides recommendations for best practices and the proper establishment and running of a spatial management unit to provide real-time data using the latest technology available.

1.4 General Aim

This study aims to explore location-based information's role in decision-making for sustainable forest management in Fiji. Since Fiji has a long history of using location-based information in forestry it is essential to explore the influence of location-based information on decision-making till now. How this information contributed to the conservation of forests, protection of forests, sustainable harvesting of forests, measurement, reporting, and verification of forests, and in decision making for sustainable forest management at the national level will also be looked at. Furthermore, the existing spatial information management systems and their influence on decision making will be studied.

1.5 Specific Objectives

Specifics objectives of this study are as follows:

1. To assess the importance of **locational information in decision making for forest management** and its contribution towards sustainable forest management.
2. To diachronically **evaluate the present and past use of location-based information in the** Fijian **forestry sector**.
3. Propose **recommendations model for the long-term sustainability of location-based information systems** in Fiji to aid in sustainable forest management decisions.

1.5 Conclusion

This chapter has briefly introduced the research establishing the core themes of this research. The next chapter looks into the literature relevant to the objectives of this study and identifies the gaps in literature which were

investigated in this research. The methodology used in this research is discussed in the third chapter. The fourth chapter details and discusses the findings of the research. The last chapter presents recommendations for location-based information systems in the Fijian forestry sector guiding towards its sustainable future based on the findings of this study and summarizes the research.

CHAPTER 2:

LITERATURE REVIEW

2.1 Introduction

This chapter reviews relevant literature of the subject matter for this research. Firstly, the objectives and its relevant literature questions are discussed to give an insight into what literature may be looked for that is relevant to this study. . ~~A~~ brief overview of how the literature review was conducted is discussed. The chapter goes on to present findings from literature which are relevant to the objectives before concluding with a summary of the literature review and identifying the gaps existing in literature for the subject matter.

2.2 Literature Review Methodology

Literature review for this research (apart from that applied as methodology) was solely based on internet search. Google Scholar was the main source of literature search based on key words extracted from the objectives of this research. Compared to other online databases such as Web of Science, UWTSD Library Catalogue and others, Google Scholar seemed the easiest to use. Google Scholar is a free to use search engine that collates academic material (articles, research publish9ings, books, conference proceedings, reports etc), both published and unpublished, from all over the internet and then filters it based on the matching key words searched and the articles popularity on the said keywords (Haddaway et al, 2015). It is also important to note that Google Scholar does not automatically sort articles by year unless a filter is set for the years and sorting is applied to sort from 'Most Recent' or 'Oldest'. Other key advantages for reasons why Google Scholar was chosen compared to other databases is that Google Scholar provides quick insights of materials such as 'Cited by' which shows a result of all articles that cited the chosen article, 'Related Articles' which shows all related articles of the chosen articles, and versions of the chosen article. These were useful tools for the researcher for a quick dive in the topic of interest. Delgado López-Cózar et al., (2019) have concluded in their study that Google Scholar has opened an entire world of

academia to every person in the world looking at its geographic coverage, inter disciplinary academic sources and the collation of the most journal databases in the world in one search engine.

In the instance where a literature of interest could not be accessed openly, access privileges of the University were used to access the material for review via the University's online library database/catalogue. In the instance where the material of interest was not available via the University's online library catalogue/database the University did have an option where a request could be sent to the librarian for access to articles which were not available via the online library database, however on personal experience, this seemed to be a time consuming process, hence, for such articles the corresponding author for the article was contacted via email to get access to the article and in all instances the authors happily shared their articles.

Table 2.1shows the keywords searched for each of the subtopics discussed in this chapter.

Subtopic Number	Literature Topic	Keywords Searched For
2.4	Sustainable Forest Management	Sustainable Forest Management, Sustainable Forest Management + Definitions, Sustainable Forest Management + History
2.5	Importance of Decision Making for Sustainable Development	Decision making, Importance of decision making, Decision making for sustainable development, Role of decision making in sustainable development, Decision making for sustainable forest management,
2.6	Spatial Information for Decision Making	Spatial information + definition, Locational information + definition, Spatial information + decision making,
2.7	Organization Structure for flow of decision-making information	Organizational structure for GIS information, Organizational structure for decision making, Organizations and decision-making structure
2.8	Retaining knowledge and skills in organization – future proof – retainer programmes	Institutional knowledge, Advantage of institutional knowledge, Disadvantages of institutional knowledge, Retaining employees, Future proofing organizations
2.9	Spatial Data Infrastructure	Spatial Data Infrastructure + Definitions, Spatial Data Infrastructure + forestry, Spatial Data Infrastructure + governments

Table 2. 1 Literature search keywords.

2.3 Structure of Literature Review

With the time limitations of this study, it was important to identify the specific literature topics that will be looked at for review to save time. To do this, a breakdown of key words and topics of interest from the objectives is presented below with its discussion.

i. **Sustainable Forest Management** – the review of this topic investigates the history of sustainable forest management, what it means, its definitions in literature, and the context in which it will be defined for this study.

ii. **Importance of Decision Making for Sustainable Development** – the review of this topic includes sustainable development as a

concept, decision making as a concept and the role that decision making plays in sustainable development.

iii. **Spatial Information for Decision Making** – this topic reviews the role and importance of location-based information in decision making, having particular focus in forestry (sustainable forest management) and environment conservation, protection, and management.

iv. **Organizational Structure for Flow of Decision-Making Information** – this topic the organizational structure for flow of spatial information systems from studies around the world.

v. **Institutional Knowledge** – this topic investigates literature of retaining knowledge and skills in organizations. Both the advantages and disadvantages of this are discussed.

vi. **Spatial Data Infrustructure** – this topic investigates literature of spatial data infrastructure systems, its operations, and complexities.

2.4 Sustainable Forest Management (SFM)

As early as the 17th century, the harmful impact of the previous use of forest resources and the necessity for future generations to continue using these resources had gained the scientific community's attention (Glacken, 1976, as cited in Martin and Diez, 2012). Increased environmental consciousness and increasing scientific understanding of environmental degradation have affected society's values and global policy, which have impacted forest management aims in the 20th century (Wang and Wilson, 2007). However, many scientists believe that the paradigm is shifting due to climate change (Ruddell et al., 2007; Bonan, 2008; Canadell and Raupach, 2008; Lemprière et al., 2013). Upon analysing different definitions of the SFM concepts in the early modern

era of 1980s and 1990s, Martin and Diez (2012) conclude that they all are just refining the definition of sustainable development given by the Brundtland Commission (1987, p. 37) *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* to apply it to forests.

Goal 15.2 of the United Nations Sustainable Development Goals (UN SDGs) 2015 is to "*promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally*" (United Nations, 2015, p. 27). There are numerous definitions for SFM, all of which are dependent on the context in which the term is used. The United Nations Food and Agriculture Organization (FAO, 2020) defines sustainable forest management as a "dynamic and evolving concept, which aims to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations". This study, together with the SDG 15.2 and the FAO definition of SFM, aims to include the protection, conservation, and sustainable logging of forests in the concept of SFM as these activities encompass the sustainability of our forests for the future generation. Hence this study will define **SFM** as follows: **'Any activity involving or leading to the protection, conservation, sustainable management, establishment and sustainable logging of forests'**.

2.5 Importance of Decision Making for Sustainable Development

Decision making is an essential part of our daily lives. Decisions shape our future and those of our future generations (Weiss, 1990; Hara et al., 2021; Upadhyay, 2021). At any point in time, any decision we make may have an impact on someone or something somehow or the other today, tomorrow, and in the near and far future. The nature of this impact (positive or negative)

depends on the decision-maker. The decisions made today determine whether we are going towards sustainable development or veering away from it. Only the right decisions made will contribute to sustainable development. Informed decision making is the right way to make decisions (Gardiner and Quine, 2000; Espey, 2018).

Many authors (Sani et al., 2016; Jeong, 2018; Blicharska et al., 2020; Wu et al., 2020), have attributed multi-criteria decision making (MCDM) to leading the pathway to sustainable development. Sousa et al. (2021) reviewed 143 published scientific articles ranging from the years 2016 to 2020 which employ MCDM methods to support decision making for achieving the UNSDGs. Their findings revealed that in 2019-2020 MCDM methodology in research has seen a rise of 112%. Of the 143 case studies, nine were specifically for SDG 15. Furthermore, 56% of the case studies that employed MCDM for SDG 15 decision-making employed a location-based approach. This study tells us that sustainable development requires informed decision-making. It is now widely acknowledged that environmental concerns must be considered at all levels of decision-making, keeping in mind the impact our decisions have on the environment.

2.6 Spatial Information for Decision Making

The most important part of scientific management of resources is information about their status (Islam and Wahab, 2005; Armada et al., 2009; Jingling et al., 2010). The type of resources and the objectives of the management system will usually decide the structure of the information system. Forest resources are one of the most vulnerable and economically important resources ~~in the world~~ today (Repetto and Gills, 1988; Ostrom, 2005; Torres-Lezama et al., 2008; Rahman et al., 2010). At the same time, it is the most important ecosystem on earth, and its destruction is seen as a threat to life on earth (Repetto and Gills, 1988; Ostrom, 2005; Torres-Lezama et al., 2008; Rahman et al., 2010). In the

case of tropical forests in particular, it is impossible to think about forestry without thinking about people or the environment (Hladik et al., 1993). People who live in or near forests are poor and depend on them for food, animal feed, wood, and money. It is important to get and manage data on resources in a timely manner if you want to manage them in a sustainable way. Before, forests were only taken care of for profit. People and the environment were given the attention they deserved. But you cannot think about forestry without thinking about the people who work there or without thinking about environmental issues.

Spatial information, a term first coined by Hopkins and Armstrong in 1985 (Keenan and Jankowski, 2019), has proven to be a valuable tool for decision making over the years, with many authors also referring to it as Spatial Decision Support Systems (SDSS) (Shekhar and Xiong, 2008; Vincent et al., 2019; Keenan and Jankowski, 2019). Vacik and Lexer (2001) investigated the use of spatial decision support systems in the sustainable management of Vienna's protection forest for water resource production. They described the interconnectedness of information which was used in a multi criteria decision making system and analysed using a GIS system to make decisions for the protection of forests. GIS today is far much greater than what it was 21 years ago (at the time of the study by Vacik and Lexer (2001), hence it has become a go to tool for any decision making connected to a location (Zerger, 2002; Phua and Minowa, 2005; Durduran, 2010; Arabameri et al., 2018; Damoom et al., 2019).

Furthermore, with recent advancements in the acquisition, processing, analysis, and presentation of spatial data, spatial decision support systems are widely being used by decision-makers as a basis for sustainable decision-making (i.e., decisions which lead to sustainable development) (Feeney, Rajabifard, and Williamson, 2001; Liu, Bai, and Chen, 2019). Academics have found that –

location, a critical factor in decision-making, is also a key determinant of sustainable decision making (Liu, Bai, and Chen, 2019).

There has been an increase in locational information's importance in decision making. Spatial decision issues require the use of locational data and information. As a result of the complexity of locational choice issues and the need to consider numerous factors, spatial decisions are usually a part of multi-criteria judgments (Massam, 1980). Janssen and Uran's (2003) experiment on the preferred method of spatial Information for decision-making found that most people prefer locational information presented in maps, followed by graphs, tables, and text format. Furthermore, the study recommended that the user of this spatial information be able to interact with it in real-time (Example, zoom in and zoom out) to see various levels of information on the maps. As this research was conducted in 2003, web maps were not a popular thing at the time; however, today, real-time dynamic maps have become exceedingly popular, displaying a lot of information with endless functionality to manipulate, analyse and visualise spatial information in real-time (Horbiński et al., 2021; Pârvu et al., 2021).

Destan, Yilmaz and Sahin (2013) in their research have stated that information about extent of forest communities is of considerable importance in forest management planning. This information is location based. Their research has demonstrated that the precision of decisions to be implemented is closely related to the accuracy of forest stand maps. The main goal of their study was to create semi-automated maps of forest stand volume calculated from ground survey data. The results were impressive with more than 97% accuracy rate when assessed against ground surveys. This they said gives a relatively quick way of delivering information to decision makers for their considerations compared to ground surveys (forest inventories) which take a lot of time, skills and require a large amount of funding (Breidenbach et al., 2021).

Takam Tiamgne et al., (2022) used GIS to assess the state of protected forests in Zambia. Their study identified suitable areas for conservation, based on standardized location-based criteria using a GIS approach. A suitability model was developed for the selection of the suitable areas, and elimination of the unsuitable ones. The findings from this approach informs decision makers about the status of protected forest areas and identifies areas for creating new ones. GIS modelling approaches inspired by such studies can be very handy for decision making for sustainable forest management. Their study although applied to a small area in Zambia is applicable to any part of the world where there is work done on sustainable forest management. However, there is no literature evidence of such models being applied to small island developing states forests or to the natural pristine forests of the Pacific.

Zhao (2006) demonstrated a fully-fledged use of GIS as a decision-making support system for sustainable forest management in China. The use of multi layered locational information of forestry and all environmental characteristics combined using GIS software on one database was shown as a particularly useful tool for decision making. One of the software used at the time was ArcMap which 16years later is now known as ArcGIS Pro and the functionality of data creation, storage, analysis, and presentation using the said software package has also been made much more advanced and user friendly. It should also be noted that this software (~~which was~~ the main software used in the study) is and has always been a propriety software which comes at a cost. At the time if this study the cost was based on single use license for the software for lifetime use and it could be used on a local machine (computer hardware) without the need of internet, however, today the updated version of the software comes in annual licenses and is internet dependent for retrieving licensing information at least every 24hours) if configured to be used offline but its major functionality today is internet dependent and requires high speed internet to deliver its full functionality (Price, 2019).

2.7 Organization Structure for flow of decision-making information.

Timely flow of accurate and reliable information throughout organizations is critical for decision making (Huber, 1990). How information is received, stored, analysed, and presented throughout the numerous operating instruments of an organization directs its informed decision-making process (Fosso Wamba et al., 2015). Research in this area of study is rare (Joseph and Gaba, 2020) although it can be traced back to Simon (1947) as cited in Joseph and Gaba (2020).

Modern day organizations are bound to integrate the use of modern information technology in their day to day running and decision making to make effective and efficient organizational progress in a timely manner with the growing world (Brynjolfsson and Hitt, 2000). Heintze and Bretschneider (2000) in their study have provided insight into the effects of organizational restructure to adapt to information and communication technology advancements. Their study initially finds that many managers are supportive of adapting to the latest information and communication technology systems to have information flow throughout their organizations. They further go on to elaborate the fact that an organization's proper structure for information flow does improve the overall performance of the organization. Although there is no direct mention of decision-making context in this study by Heintze and Bretschneider, studies such as one by Dean and Sharfman (1996) have suggested that the overall performance of any organization is always based on the decisions made at various levels of the organization.

2.8 Retaining knowledge and skills in organization – future proof – retainer programmes

Brain drain is a major concern for developing countries (Docquier et al., 2007; Ngoma and Ismail, 2013). Talent is a unique resource and driving force that may help an organization acquire a lasting competitive edge and decide its success in the face of globalization, increased information availability, and the rise of new economies (Horváthová, 2011; Collings, 2014; Hongal and Kinange, 2020). Because of this "war for talent" large-scale issues with human resources, such as brain drain and a shortage of skills, are being exacerbated (Michaels et al., 2001; Tarique and Schuler, 2010). Talented individuals are now more easily leaving their country in quest of better living standards and employment opportunities in developed nations because of shortage of skills in the international arena (Collings, 2014). Brain drains have a negative impact on an organization and the ability of the organization to perform as required to do so to deliver its objectives and plans for development. Talent migration is influenced by a variety of social, economic, demographic, and political variables (Baruch et al., 2007). As a result, it is critical to identify the most critical factors for each organization to minimize the impact of brain drain and maximize the organizations' ability to recruit and retain human resource.

The concept of institutional memory for an organization can be traced back to Becker (1932, as sighted by El Sawy et al., (1986) who states that institutional memory is knowledge of an organization which lives in a person through the experiences that one goes through during their time in an organization. The loss of institutional memory is loss of organizational knowledge (El Sawy et al., 1986).

Talent management has been a critical issue faced by modern day organizations (Cappelli, 2008). Recent research has shown that the recruitment of talented individuals with specialized skills, further training them in the field

of specialized knowledge at the organizations cost so that they perform their duties in the best manner for the organization, and then retaining these employees remains a challenge throughout the world (Cappelli, 2000; Bernthal and Wellins, 2001; Argote and Guo, 2016; Useng, 2017; Shah and Asad, 2018).

2.9 Spatial Data Infrustructure

Environment data is an ever evolving and developing form of information (Jørgensen, 2013). The investments in enhancing the capability of collecting, storing, analysing, and sharing environmental has seen a huge rise in recent years (Kozak et al., 2008; Kienast et al., 2009; Di Piazza et al., 2011; Helsel, 2011; Ott, 2018). However, a major challenge has been seen in building infrastructures that enable institutions and organizations to use these environmental data. This is where Spatial Data Infrastructures come in.

Rajabifard and Williamson (2002) summarise spatial data infrastructures in sharing data inter agency. They state that aim of creating spatial data infrastructures is to create an environment where all stakeholders, from consumers to producers, can work hand in hand and use technology to reach their spatial data goals at different political and administrative levels. The major advantage of this is that organizations and institutions which are working towards a common objective, such as climate change mitigation and adaptation, carry out their respective work on the same page. While this gets work done at a faster pace, it also prevents repetition of work and the objectives are collectively achieved much sooner than expected, states their study.

In their study, Fonseca et al. (2009) have laid out the need for such a Spatial Data Infrastructure which leads to Global Forest Information System (Câmara et al., 2009). Their focus is on the Amazon Forest Fires and how Spatial Data Infrastructures could help make quick decisions and have inter agency collaboration to prevent catastrophes at the Amazon forests. A key take from this article is the importance of spatial information relayed on how it can help

solve problems of the Amazon Forest. A further outline is the importance and role played by Spatial Data Infrastructures in the management of forest.

2.10 Research Gap

Many studies have focused on policy-level decision making approaches for sustainable forest management. Most literature has also focused on using GIS for a multi criteria-based approach to decision making (Geneletti, 2019; Andrew and Katy, 2008). This study will fulfil the gaps in literature by **focusing on the locational information component of that decision-making process**; Firstly, **how has locational information assisted in decision making and directed decisions in the past,** and secondly, it will **provide recommendations of best practice for a sustainable future** in using location-based information to support forestry decision making. There is a fine line between these two fields of study because location-based information is usually, in today's world, derived from GIS analysis and databases; hence when it comes to the people who produce this information, they are using a GIS system to produce location-based information for decision making. On the broader approach, however, how this location-based information has assisted decision-making over the years in Fiji is one of the significant study objectives. A minor study objective is to study the Unit's management, structure, and running, which produces this information.

A significant research gap is seen in decision-making studies **for sustainable forest management at the base level (fieldwork level)** (Weintraub and Bare, 1996; Rönnqvist et al., 2015). For example, how do they make decisions when someone decides to alter the structure of a forest (reforestation or cutting down of trees). How does location-based information guide their decision-making process? This study is focused on how have Foresters, right from the field up to the decision-makers for forestry in Fiji, over time, used locational information to make decisions for the sustainability of forests and provide a

guide for making the best use of locational information for future decision making.

2.11 Concluding Summary of Literature

Literature for the subtopics (2.4 – 2.9) discussed in this Chapter are of a wide variety. It is sometimes difficult to make sense of the literature in the context of current research, but best attempts have been made to only focus on the parts of literature which make sense in the context of this research. Table 2.2 presents some key point summaries of each of the subtopics and their literature findings.

Subtopic Number	Literature Topic	Findings
2.4	Sustainable Forest Management	• Remains a critical issue for the world. • Will be key in fighting climate change
2.5	Importance of Decision Making for Sustainable Development	• Decision making is they key in achieving sustainable development as every action is based on a decision
2.6	Spatial Information for Decision Making	• Spatial information is key to making decisions due to the criticality of location and it being a key factor in natural resources of the world.
2.7	Organization Structure for flow of decision-making information	• How an organization is structured for flow if information will determine the organizations future as the success of organizations is dependent on how efficient their decision-making is.
2.8	Retaining knowledge and skills in organization – future proof – retainer programmes	• Institutional knowledge is valuable for lessons learnt from the past so as not to repeat the same mistakes again, but it can also be a hindrance to development and adopting to new ways of working due to old mindsets.
2.9	Spatial Data Infrastructure	• Plays an important role in data sharing arrangements and having all data in one place for analysis, visualization and decision making.

Table 2. 2 Summary of literature findings.

CHAPTER 3: METHODOLOGICAL REVIEW

3.1 Introduction

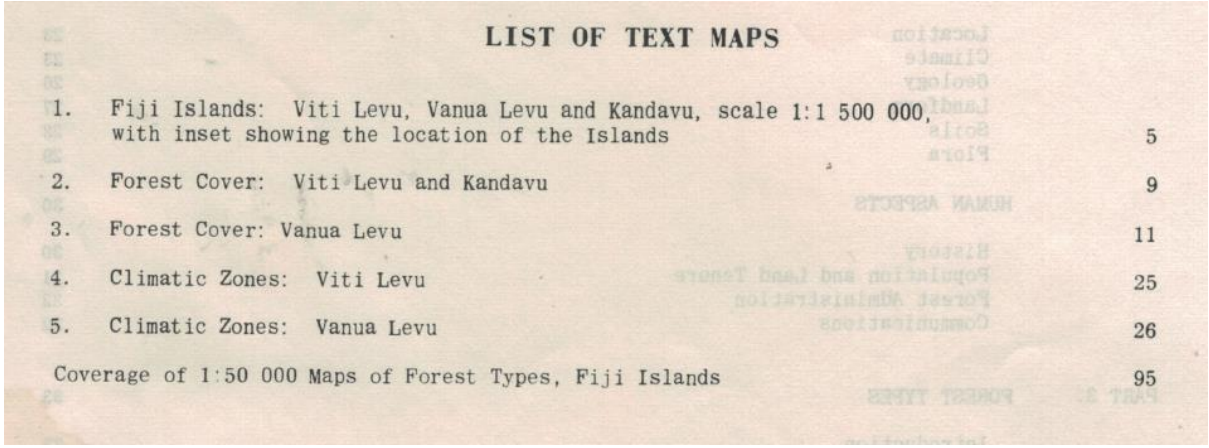
This study mainly employed qualitative methodologies to study human perceptions of decision-making. The chapter looks at the methodology used to gather and analyse data for this study. It further identifies the limitations of the methodology used, where there may be bias in the data collected, and how these biases were treated.

A growing number of researchers have recently used qualitative research methods to study the human dimensional aspect of environment and conservation (Skov et al., 2007; Rondinini and Chiozza, 2010; Macura et al., 2019; Prokopy et al., 2019;). Since decision making is human behaviour, using qualitative methods for this study helped understand how and why things happened over time and how it has shaped the changed thinking for a better future.

To study the human dimensional aspect of decision making this research focuses on a group of people (approximately one hundred) who have been working in the Forestry sector and are currently employed by the Ministry of Forestry utilizing location-based information in their work as foresters. Since quantitative research methods usually require a large sample (Yilmaz, 2013; Marshall et al., 2013), and since this study has a confined one, employing qualitative methods seemed most suitable. In order to get an insight into decision making thinking, qualitative methods are more viable than quantitative as decision making cannot be easily quantified, especially the rationale behind an individual's decision-making approach (Hagbaghery et al., 2004; Weischedel et al., 2005). Further in this chapter it is described the different methods of data collection employed to gather information from these officers.

Using qualitative methods this study also aimed to validate human accounts of the past by the study of historical materials. Historical materials dating back to 1925 (97 years ago) are available at the Ministry's offices and at the archives

building. A lot of historical materials from the early 2000s till date are also available in digital format. Some materials which were in hard copy have been scanned by the Ministry for an insight of the current leadership in the past achievements such as that of the National Forest Inventory 1969 (Figure 3.1).



LIST OF TEXT MAPS

1. Fiji Islands: Viti Levu, Vanua Levu and Kandavu, scale 1:1 500 000, with inset showing the location of the Islands 5

2. Forest Cover: Viti Levu and Kandavu 9

3. Forest Cover: Vanua Levu 11

4. Climatic Zones: Viti Levu 25

5. Climatic Zones: Vanua Levu 26

Coverage of 1:50 000 Maps of Forest Types, Fiji Islands 95

Figure 3. 1 An excerpt from the scanned copy of NFI 1969 (Source: Ministry of Forestry, 2022)

The presence of these materials in hard copy and in digital format is a huge added advantage for this study as it gives documented evidence of the past. Forestry being a field in which development of its core subject; forests; takes at least 10 years or more and its utilization, conservation and protection happen over prolonged periods of time. The farther one goes back into the past the more of the subject specific details are unearthed in the different phases of forestry development (Yamaura et al., 2021). Study of historical materials also gives a chance to look back into history and make decisions based on the lessons learnt from it. It also gives weight to this study by the fact of studying the past to learn why the present is where it is today (Lawrence, 1984). Further on in this chapter it is articulated how these historical materials were analysed and put into context.

3.2 Survey

In an empirical study, Dias (2007) used surveys to study the impact spatial information had on users to contribute to sustainability. This methodology helped understand the impact different information dimensions (e.g., having

the information or not) and different information mediums had on the behaviour of tourists towards natural areas.

Since the popularity of the internet, web-based survey design and deployment services are of a lengthy list ranging from open source to paid services (Wright, 2017). In recent times open-source web-based survey deployment services have become popular for researchers to gather data (Shoham et al., 2021; Elbeck, 2014), with increasing contributions of developers to open-source projects and the trust of researchers in its security (Hertel et al. 2003).

For this study, a web-based survey was designed to study the specific experience and thoughts of foresters at various levels with location-based information. Paper based surveys were not employed due to their time-consuming nature. Although studies such as the one by Greenlaw and Brown-Welty (2009) have shown that a combination of both web-based and paper-based surveys usually result in collection of ideal data, they do not shy away from the fact that paper-based surveys are time consuming and, in some cases, expensive compared to web-based surveys (Greenlaw and Brown-Welty, 2009).

The web-based survey for this study was designed and deployed in ArcGIS Survey123. The survey was designed keeping in mind limitations of such surveys. Kost and Rosa (2018) have concluded in their study that short surveys have a higher response rate compared to lengthy surveys, hence this survey was kept as such that it could be answered in less than 2 minutes. Anonymity was a major objective of this survey as studies have shown that respondents tend to be more honest with their responses if they are confident of their anonymity (Tourangeau, 2018; Schleyer and Forrest, 2000). No personal information was collected and since it being a web-based survey anonymity to the respondents was guaranteed.

The target audience for this survey were the technical staff of the Ministry and those involved in executive, planning and policy decision making for the

technical forestry work because these are the employees who would be involved doing operational forestry work and decision making. Employees other than these of the Ministry are employed in support capacity such as Human Resource Managers, Accountants, Clerks and so on.

This survey acted as a pilot study and answered key questions from the objectives. Table 3.1 shows how the survey questions helped gain an insight into the objectives of this research.

Research Objective	**Information Gathered** from **Survey**
Establishing the importance of locational information in decision making for forest management and its contribution towards sustainable forest management.	How location-based information has aided and made a difference in a forester's decision making
	The different specific uses they have made of location-based information for their decision making.
	How often do they use location-based information in their work as a forester
Study the present and past use of location-based information in the Fijian forestry sector.	The limitations they have faced with this information
	At what instances have they needed location-based information for planning

Table 3.1 Connectedness of research objectives and information gathered from survey.

Table 3.2 details the three identifiers which were used in this survey.

No.	**Identifying Question**	**Identifier**
1	When did the person answering the survey questionnaire start working for the Ministry	Before Year 2000
		2000 to 2017
		2018 to 2022
2	Which part of the Ministry do they work in now	Operations Division
		Research and Development
		Leadership and Policy
3	Which part of the Ministry have they spent most time in	Operations Division
		Research and Development
		Leadership and Policy

Table 3.2 Survey identifiers.

Identifier one was used to weight the answers from the experience of time they had in the Ministry which would give weight to their views and accounts of the past. The detailed specific questions were populated based on the answer of identifier two. This was done because their answers would be influenced by their daily lives as foresters now (Gershunskaya, 2011). Identifier three was used as a long-term influence factor where the overall answers would be affected by the lifetime experience of the person answering the question.

At the end of the survey the respondents were asked if they would be kind enough for semi structured informal interview.

A link was sent out to all the officers of the Ministry with a request to fill in the survey via a staff group email on Monday 2nd May 2022. They survey was open for a total of 30 days and stopped gathering responses on Thursday 2nd June. They survey gathered a total of twenty-two responses which are analysed and discussed in the next chapter.

3.2.1 Survey Response

As of 10th May 2022, there are 142 established staff within the Ministry (Ministry of Forestry, 2022). A breakdown of this could not be obtained but was analysed based on the authors knowledge of the Ministry human resource distribution. Based on this analysis a total of one hundred responses were expected in the survey had the whole target audience responded to it. The total responses received to the survey deployed for this study were twenty-two of which two were excluded from the analysis as non-target audience of the survey answered them.

Wu et al., (2022) studied a total of 8,672 studies of which 1,071 had reported online survey response rates and concluded that the average response rate from online surveys were approximately 44.1%. However, this rate was also including surveys which were deployed in distinctive styles, example; the target audience were clearly defined, individually targeted survey requests were sent,

follow ups were done and so on. Based on the same the 20% response rate for this study can be deemed sufficient to account for the whole sample considering the fact that there were no follow ups or reminders sent.

3.2.2 Identifying the Respondents.

The survey used three questions to identify who was responding to the survey. The identifiers are discussed in Section 3.2 of the previous chapter.

A breakdown of the respondents' identifiers is shown in pie charts below.

Figure 3.1 indicates that 15% of the respondent's started working for the Ministry before the year 2000, 45% started working between the years 2000 and 2018 and 40% started working between 2019 and now, which is 2022.

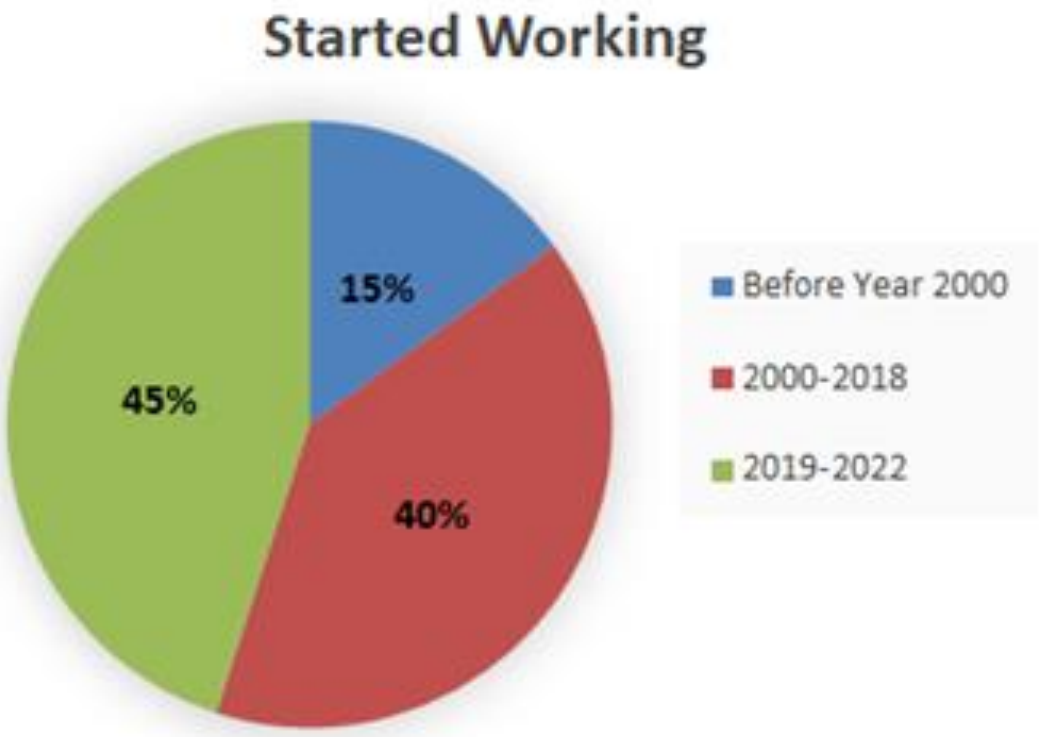


Figure 3. 2 Breakdown of when the respondents' started working for the Ministry.

Most respondents are recent employees of the Ministry but there is no short of those who had started working earlier. A limitation of the survey can be that there is no equal distribution of respondents in the three periods of when they started working. Majority of the results from the survey is view of the employees who started working for the Ministry recently, only 15% of responses constitute the views of prior to the year 2000, which is more than 22 years of experience, and 40% constitute the views of prior 2018 which is 4 to 22years of experience.

Figure 3.2 shows a breakdown of respondents by the Division they currently work in.

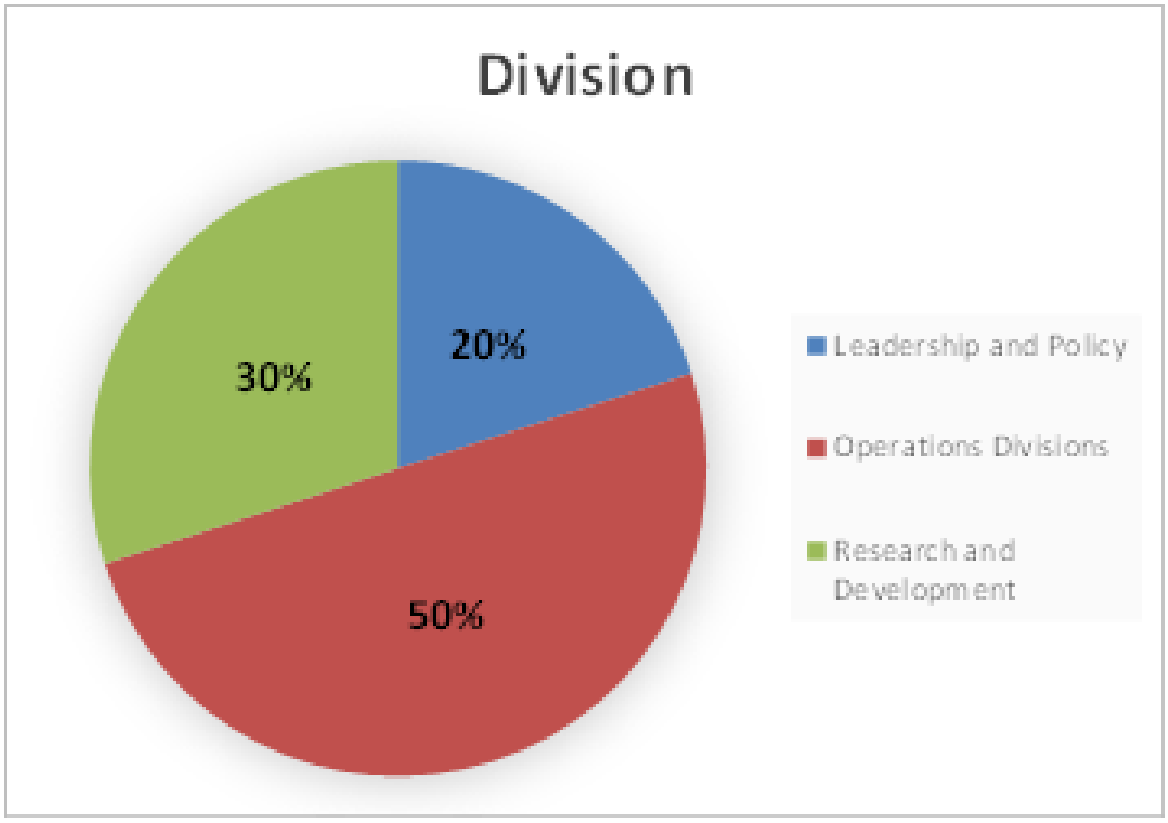


Figure 3.4 Breakdown of respondents by the Division they work in.

Twenty percent are currently working in a Leadership and Policy role. This role is of Director level and above who have one or multiple team(s) working under their supervision and direction. The decisions they make in the Ministry have an impact on policy and legislation of the sustainable development of forests in Fiji.

Thirty percent of the respondents currently work in the Research and Development Divisions. These Divisions include the Forest Products Timber and Trade (formerly known as Timber Utilization and Research Division), Silviculture Research Division, Forestry Training Centre and the Forest Resource Assessment and Conservation Division (formerly known as the Management Services Division) which also includes the Parks and Reserves Unit.

Fifty percent of the respondents were from the Operations Division. These respondents can be from the North, Central/Eastern or Western Operations Divisions. These are field foresters who practice practical forestry in the field ranging from forest establishment, harvesting, protection, conservation, and management. Having 50% of the respondents from the operations division is a good indicator for the study as views of field foresters will be well reflected in the survey results which would clearly answer questions of the first objective of this study.

Figure 3.7 shows a breakdown of respondents by the Division in which they have spent most time. Research (Dobus et al., 1998; Bandura, 2006[6]; Hägglund and Leuze, 2021; Hartung et al., 2022) has shown that people's views are shaped by the environment they have spent most time in. Therefore, this question was necessary to finetune the respondents' views as where they were coming from. Majority of the respondents had spent most of their time within the Ministry at the Operations Divisions.

[6] In the field of Psychology.

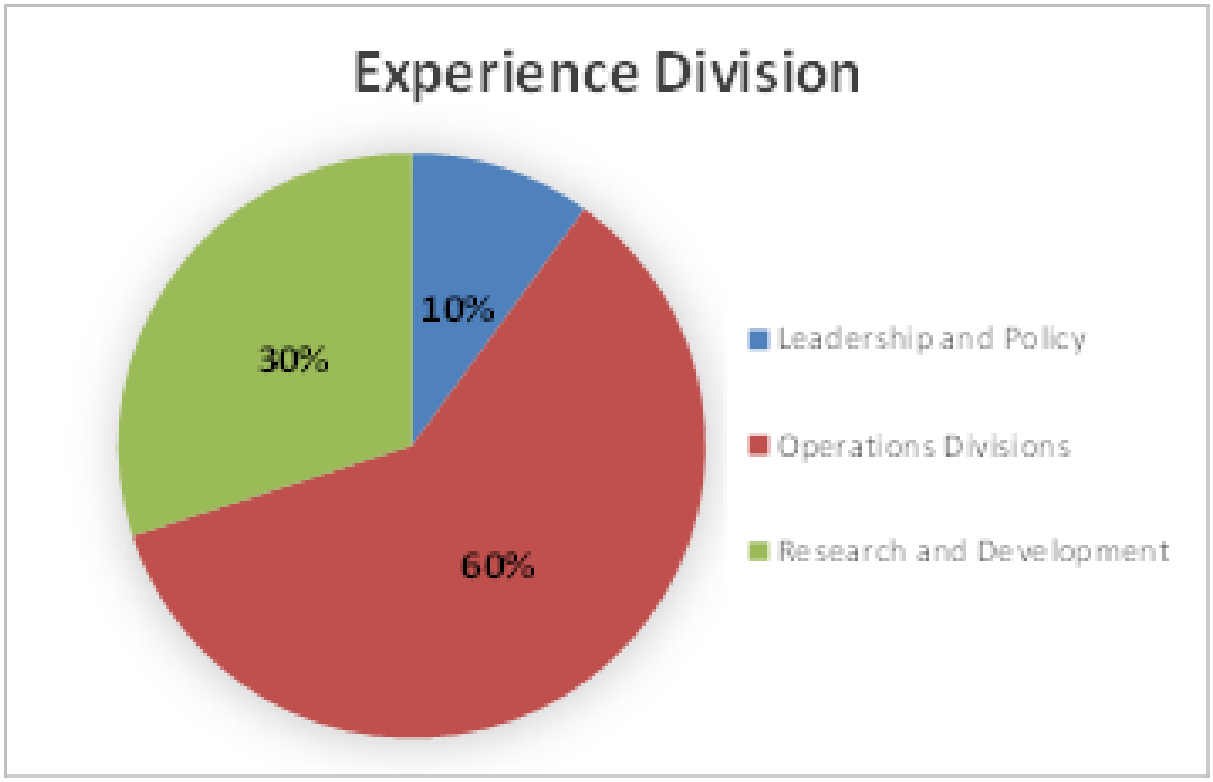


Figure 3.5 Breakdown of respondents by the Division they have most experience in.

There are two conclusions from the identifiers:

1. Majority findings (45%) will represent views of recent employees of the Ministry who have an experience of 0 to 3years within the Ministry (or Forestry sector of Fiji). Although the fact remains that there is still a fine line with the second most popular views (40%) which would be of employees having almost 20years of experience within the Ministry.
2. Majority of the findings are influenced by Operations Divisions minds as they hold the majority percentage who have responded to the survey and where the respondents have spent most time.

Further questions of the survey were divided in three groups: Operations, Research and Development, and Leadership and Policy. There were minor differences in the three different group of questions. Depending on the respondents answer to question on the Division they work in, the survey populated this further group of question of the Division they work in. This was done to get an insight into views of officers of the division they work in.

3.2.3 Limitations

Since this survey was web based it would have been difficult for rural Fiji foresters to access and answer it due to limitations of their network connectivity. These rural foresters are integrated into the community and are the guardians of some of the most pristine native natural forests of Fiji and getting their views and perceptions of location-based information would have been useful for this study. To overcome this, paper-based surveys could have been delivered to these foresters, but due to it being a time-intensive exercise and the time limitations of this study, it did not seem viable.

A second limitation was in the deployment of the survey. The IT team of the Ministry who were requested to deploy the survey link to the Ministry group emails were not briefed on the target audience hence they survey request/link was sent to emails of all Ministry staff which included the non-target audience such as clerical officers, accountants, human resource managers and such. A second email was sent to all to identify the target audience but by then two clerical staff came forward in mentioning that they had already submitted the responses to their survey. Both had also submitted their name and details in agreement for an interview, so their responses were identified and were not accounted for in the analysis. However, it remains a major limitation in the sense that if any other such staff submitted a response to the survey and not identified themselves, their response will be accounted for as a target audience response when actually it is not.

3.3 Semi-Structured In-Depth Interviews

Semi structured in depth interviews are a medium of research which give an insight into a broader range of information than proposed by questions (Tiu Wright, 1996). Due to this very reason this form of interview was chosen compared to other forms of interviews. Structured interviews do not give the

interviewees leeway to present extra information as both the interviewer and interviewee must stick to the scripted questions. Unstructured interviews at times give so much leeway that a lot of extra unnecessary information is gathered and as such it is difficult to take out the key points of context from the whole interview. Semi structured interviews give a scripted structure of the interview and give both the interviewer and the interviewee some leeway for extra information give and take. Semi structured interviews have long been common for qualitative data collection (Tiu Wright, 1996y). Semi-structured interviews (Perez et al., 2015; Young et al., 2018; Ranjan et al., 2019) were employed in this research to gain an insight of the interviewees in all three objectives. The interviews gathered information to establish the importance of **locational information in decision making** for forest management and its contribution towards sustainable forest management. They also gave an insight into the present and past use of location-based information in the Fijian forestry sector and finally they gave opinions of the ideal model for a sustainable future of the spatial information management unit for providing decent quality location-based information to make sustainable forestry decisions.

Fourteen current officers of the Ministry were interviewed of the approximately fifty working in technical forestry positions. Some were identified from the pilot survey and others randomly picked as the researcher came across them. These officers ranged from the most senior executives to the foresters who work right in the field as junior support staff to the operations of the Ministry.

Before beginning this discussion, the subjects were informed that this discussion would help in the research study of the researcher for his dissertation and may influence the future of location-based information in the Ministry based on the findings. They were also informed that all their views, accounts and perceptions would remain anonymous in the study and would only be known to the researcher.

The identifiers used for the interviewees were –

1. The number of years they had spent in the Ministry, and
2. An account of the researcher on their brief background of what their role had been in the Ministry in these years.

Swain and Spire (2020) have identified that informal conversations can sometimes give insight into information/data which are otherwise "missed opportunities" to add "context and authenticity" to known data from other sources. The interviews for this study mostly ran in form of informal conversations in random settings. Formal interviews have strict questions and require answer to specifics which does not give the interviewee leeway to present their own views and perceptions in the wider framework of things as highlighted by Swain and Spire (2020).

The discussion themes posed by the researcher to the interviewees were directed to three main topics:

1. What do you think is the value of location-based information in a forester's daily field life?
2. Do you think decentralizing FRAC to have a GIS Officer/Data Officer in each division will be a promising idea?
3. What is your opinion of the current data flow within the Ministry of location-based information? Do you think NFMS will solve the problem?

During the interview, the researcher took brief notes on an electronic note pad. After each discussion session the researcher noted the details of the interviewee and gave them an anonymous ID which was stored in a Microsoft Excel Database. Their views on the three points of discussion were also summarized and noted in the excel.

3.3.1 Limitations

Some of the officers interviewed were junior to the researcher in their role in the Ministry. Due to this they may have been putting up views which they would have thought that the researcher was looking for rather than their own independent views.

The interviews all remained as anonymous as possible therefore the discussions and conversations could not be recorded for the researcher to go back to and evaluate it. It was fully dependent on the researcher's own memory and the little notes that he was able to take. This can be a major bias as what the researcher can recall from the discussions and his notes will be accounted for which has the fact that some points might be missed which could have been important points.

Parts of these interviews also record historical recalls of the interviewee's experiences and views. Since these are personal accounts and judgements it cannot be quantified to an authoritative basis of information. However, since this was the best means to gather information, it was adapted.

3.4 Study of Documentation, SOPs, and Historical Materials

Historical materials, internal documentation and standard operating procedure documentations were studied to establish the use of location-based information in policy and decision making for forestry. This also helped analyse the importance of location-based information in guiding policy, regulations and laws which impacted the development of forests. Table 5 shows a list of materials studied and details.

Material(s)	Notes	Pages
State of Environment Report, Fiji – 1992.	-Available online: https://wedocs.unep.org/bitstream/handle/20.500.11822/8867/-State%20of%20the%20Environment%20Report%20-%20Fiji-1992SoE-Fiji.pdf?sequence=3&amp%3BisAllowed=	Browsed full briefly and focused on locational forestry component. PP: 33-34 and 53-59
State of Environment Report, Fiji – 2013.	-Available online: http://macbio-pacific.info/wp-content/uploads/2017/08/State-of-Environment-Report-2013.pdf	Browsed full briefly and focused on locational forestry component. Pp: 70-76
National Biodiversity Strategy and Action Plan – 2017-2024	-Available online: https://theprif.org/sites/default/files/2020-08/Fiji%20Action%20Plan%20and%20Strategy%202017%E2%80%932024.pdf	Browsed full briefly and focused on locational forestry component.
National Biodiversity Strategy and Action Plan – 2020-2025	-Available online: https://www.mowe.gov.fj/wp-content/uploads/2020/06/National-Biodiversity-Strategy-Action-Plan.pdf	Browsed full briefly and focused on locational forestry component.
Policy and legislature – Fiji Forest Harvesting Code of Practice, Forest Act, Cap 159 and Fiji Forest Policy 2007.	Available online: http://www.paclii.org/fj/legis/consol_act_OK/fa98/ https://www.forestry.gov.fj/docs/policies/FijiForestPolicyStatement.pdf	Browsed full briefly and focused on locational forestry component.
Annual Reports of the Ministry of Forestry	Available online: https://www.parliament.gov.fj/wp-content/uploads/2021/12/178-Ministry-of-Forestry-Annual-Report-2018%E2%80%932019.pdf https://www.parliament.gov.fj/wp-content/uploads/2021/12/177-Ministry-of-Forestry-Annual-Report-2017%E2%80%932018.pdf	Browsed at least 5 (2000/2001, 2005/2006, 2006/2007, 2017/2018 and 2018/2019) briefly and focused on locational forestry component.

	Available in hard copy at Forest Resource Assessment and Conservation Division and Central/Eastern operations Office.	
National Forest Inventory Reports (1969 and Draft 2006)	1969 NFI scanned copy available at Forest Resource Assessment and Conservation Division office and 2006 draft NFI soft copy available at Forest Resource Assessment and Conservation Division office.	Browsed full briefly and focused on locational forestry component.
Stand Level Forest Inventory Planning and Reports	Available Forest Resource Assessment and Conservation Division Office.	Browsed at least 5 briefly and focused on locational forestry component.
Divisional reports of the different divisions at the Ministry.	Available at Central/Eastern Office.	Browsed at least 5 briefly and focused on locational forestry component.
National Forest Management System documentation.	Available in soft copy at Forest Resource Assessment and Conservation Division office.	Browsed full briefly.
Ministry of Forestry archive at the Divisional Offices - included maps, survey reports.	Available in hard copy at Forest Resource Assessment and Conservation Division office and Central/Eastern Office.	Browsed briefly.
Presentations of the Pacific Geographical Information Systems and Remote Sensing Conference.	Available online: https://gisconference.gsd.spc.int/#, http://www.pgrsc.org/	Browsed briefly and had a detailed look at presentations on Forestry theme.
Newsletters of the Pacific Geographical Information Systems and Remote Sensing Council.	Available Online: http://www.pgrsc.org/gis-remote-sensing-newsletter/	Browsed briefly throughout.

Table 3.3 Details of Historical material studied.

These historical materials provided an insight into the work of Forestry which relied on location-based information and the vital role of location-based information developing Fiji's forests into what it is today.

3.4.1 PGRSC Newsletters.

The Pacific GIS and Remote Sensing Council Newsletter formerly known as the Fiji GIS and RS Newsletter dates to 1993. The newsletter which has now gained an ISBN number for its publications, was initially designed to be as a collection of articles for work done in the GIS and RS domain of Fiji and later consolidating that of the Pacific (Wolf, 2022). In its initial years, the newsletter was published by the efforts of the Ministry of Forestry officers based at the then Management Services Division of the Ministry and acted as a work update forum for GIS/RS users of Fiji (Forstreuter, 2022). Since it dates to 1993 with proper digital record of all the newsletters published, this newsletter is a good basis to gather location-based information and data work in the forestry domain and the Ministry of Forestry. Some of these articles also gave an insight into how the work done on location-based information framed decision making of foresters.

3.4.2 Limitations

It was impossible to access some of the digitally stored historical information such as those in floppy disks since a machine which could read floppy disks could not be found. Due to no proper inventory (records) of files and information storage a systematic review of historical materials could not be done. Furthermore, due to the new developments in technology, it would also be unfair to compare some of the historical data quality, accuracy, and timeliness to today's standards.

A lot of historical information about these historical material (as the evolution of the PGRSC Newsletter) is reliant on oral history which is dependent on a person's personal accountability of the events of past. These can sometimes be wrong or misinterpreted based on the persons personal judgement.

3.5 Study of Existing Location Based Information Systems

The current location-based information systems, its dissemination procedures and its use in decision making were investigated first hand. The human resources structure for creation, provision, dissemination, management, and storage of location-based information were investigated. Based on the historical account, study the current systems in action help set the scene in what has changed. This would indicate how this change has impacted the use of location-based information in forestry and its impact on the sustainable development of forests. If there has been a negative impact from the change, are there any lessons to be learnt from history which can better shape the future and if the impact has been positive, how history has shaped this impact and if there are ways to make the systems and processes better.

Limitations: The researcher has close ties to the current systems of location-based information systems in place within the Ministry, therefore it remained a challenge to study it as an independent academic. Repeatedly the researcher would drop everything, take a step back, remind himself of being an independent academic and then start again. However, the issue remains a limitation of this aspect of methodology.

3.4.1 Participant Observation

Engaged participant observation is a long-used methodology (Vinten, 1994). The methodology has been commonly used to collect data of behaviour, responses, reactions, organizational processes, existing systems, and existing capacity of organizations (Kawulich, 2005). Robey and Taylor (2018) provide a guide on how to conduct participant observation in an environment where a researching scholar is an engaged participant.

In studying the current systems of location-based information processes at the Ministry, a day was spent with the officers of the Ministry in a map reading training. The training was held in the Central/Eastern Operations Division of the Ministry. This training was held as a refresher to help the officers refresh their skills in map reading of harvesting plan maps. Part of the training syllabus also included field exercise using a handheld GPS where participants practiced locating points of interest in field which were identified on paper maps.

This observation helped gauge the importance of location-based information for the field officers, how it fits in their daily lives as foresters and their individual experiences with it.

Towards the end of the training an informal Talanoa[7] session was also held with the participants to gauge their experiences of the training and their views on the importance of location-based information in their work as foresters. These conversations did not count in the earlier methodology of interviews but as participant observation.

A second observation of officers working in the current location information provision division of the Ministry (FRAC) was done over the month of July. How these officers operate, communicate, their capabilities and their operation systems, difficulties faced were studied.

Limitation: All officers in the training were junior in rank to the researcher hence there was a reluctance of open conversation due to the Fijian culture of respect for seniority. The trainer was also a subordinate of the researcher hence the training on the observation day could have been a bit different from other days. This is a particular data bias in terms of getting real data. However, it still reflects a great picture of what is happening on the ground.

[7] Talanoa is a term mostly used in Fiji and other Pacific islanders whereby a group of people engage in conversation. The aim of Talanoa is to hear each other out while being respectful of everyone's opinion.

In office – all officers were subordinates of the researcher; hence they must have been on their toes in their work compared to other days. But at the end of the day, it just remains a possibility.

3.6 Conclusion

Four key methodologies used in this study (4.2 – 4.5) are qualitative in nature. A key limitation of all the methodologies of this study is that the whole methodology is focused on the Ministry of Forestry in studying the role of location-based information for sustainable development of Fiji's forests, however, there are other organizations/stakeholders who also have authority in sustainably managing Fiji's forests. For example, the iTaukei Land Trust Board which is the landlord of all iTaukei land[8] in Fiji has the legal authority to manage all forests on iTaukei Land in Fiji. Other plantation cooperations which are lessee to the iTaukei Land Trust Board - Fiji Pine Limited and Fiji Hardwood Cooperation Limited have the legal authority to manage all lands under their respective leases. Nonetheless, the Conservator of Forests of the Ministry of Forestry in Fiji still does have a critical advisory and consulting role in all these organizations, hence the Ministry of Forestry becomes they key organization in Fiji responsible for the sustainable management of forests and guiding other agencies towards the same on forests which is under their legal authority.

The limitations identified for each methodology ~~of this study~~ have been best attempted to be overcome however some limitations remain and due to time constraints ~~of this research~~ they could not be overcome. In future, such studies should employ a mixture of qualitative and quantitative methodologies to have quantified results for the findings such as exact figures in how many times a week a forester at a certain level uses location-based information in their decision making.

[8] Almost 87% of Fiji's total land area is iTaukei Land (Kumari and Nakano, 2016)

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

There is considerable evidence of location-based information being used in the Fijian Forestry sector since the early 1950s with evidence of the Geographical Information System since 1991 (Vakacequ, 2015; Frostreatuer, 2022). This information has been used to make field decisions, monitor reports, and verify forest resources (Vakacequ, 2015). They have also been used to build and drive policy level decision making and implementation of policies for the sustainability of Fiji's forests (Vakacequ, 2015; Forstreuter, 2022). However, the timeliness, accuracy and quality of these information remain in question (Anonymous, 2, 2022).

Evidence suggests that the development and use of harvesting plan maps, forest extent information, forest and nature reserves information have also been long used (Vakacequ, 2015; Frostreatuer, 2022; Anonymous, 2, 3, 14, 15, 2022). These are some location-based information which have always been popular within the Ministry as they were always needed for decision making (Anonymous, 2, 3, 14, 15, 2022). Over time it has had its difficulties with different provision systems and usages. Other locational information needed for decision making, such as protected areas, areas of national significance, biodiversity hotspots, cultural no go zones, and many others, have also been present with other organisations in the country. However, the level of access of the Ministry to all this cross sectoral information, its timeliness and incorporation into the Ministry's planning process remains an issue till date (Anonymous, 1, 2, 13, 14, 2022).

It can be concluded that over time - while location-based information has continually been used to make decisions for sustainable forestry in Fiji, management attention has not been paid particularly to the location-based information provision systems and its development until recently. This can be seen from the rise and drop of information provision systems at least in two

instances (year 2000 and year 2018) since 1991. Transitional arrangements and knowledge and skills retainer systems (if any were in place) have not worked.

This chapter presents the findings of the study using the methodologies stated in the previous chapter. The findings are described and discussed to provide an insight into the information gathered. Each of the subtopics begin with a brief reference to the objective it addresses to give context of the findings and discussions that follow. All attempts have been made to keep the findings anonymous wherever possible, however some references are made to people who have agreed for their actual names to be included for this study.

4.3 Usage of Location Based Information

These results address the first and second objective of this study which is the importance of locational information and its usage in the forestry sector of Fiji. **The importance of location-based information is quantified here by its usage and the type of location information used (if so), and its present usage is quantified by the results if its usage.**

All three groups had this first question which asked the respondents questions on utilization of location-based information in their work and its frequency.

For a first the respondents had a Yes/No question to answer if they had ever used location-based information in their work. 100% of the responses to this question were on Yes. If this sample were to be statistically spread to the 100% of the target population, it would mean that there is not a Forester in the Ministry who has not at one time or other needed location-based information.

A follow up question to this was the frequency of usage. Figure 4.1 presents an analysis of the results gathered.

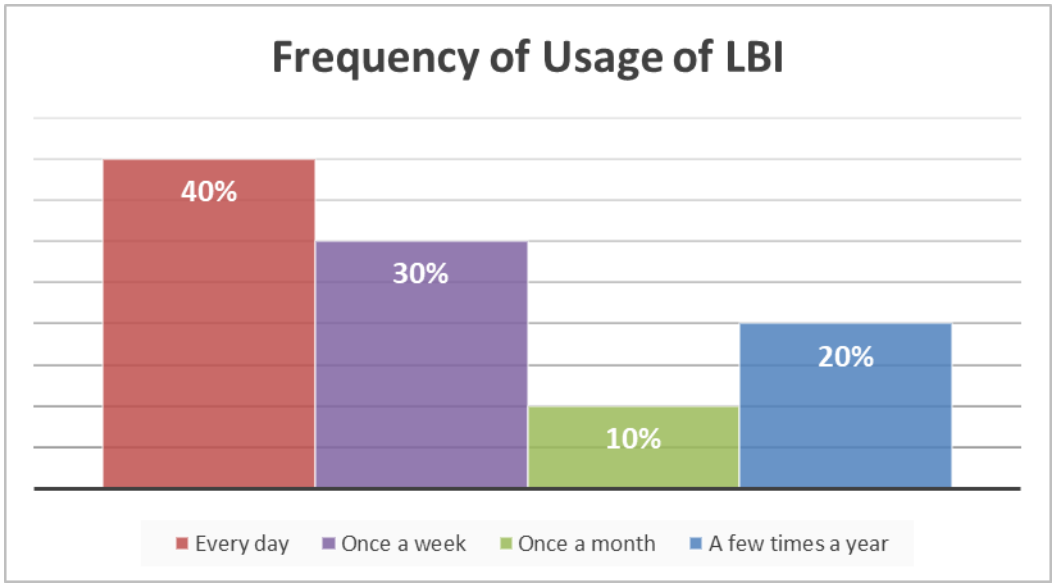


Figure 4. 1 How frequently is location-based information used in the Ministry.

The results indicate a good frequency of usage. Almost 70% of the respondents have used location-based information in their work one time a week or every day. Eighty percent of the respondents use location-based information every month one or multiple times. Twenty percent have indicated that they use location-based information a few times in a year.

The above 2 results are a proper indication of the importance of location-based information in Forestry. This result also turns our head towards the accuracy and timeliness of the location-based information that is being used. If all Foresters working towards the sustainable development of Fiji's forests are using location base information in their work, this information should be ensured to be at its possible highest accuracy, reliability and efficiency for their proper decision making.

4.4 Type of Location Based Information Used

These results address the first and second objective of this study which is the importance of locational information and its usage in the forestry sector of Fiji. **The importance of location-based information is quantified here by the type of location information used (if so), and its usage is quantified by the frequency it is used in**.

All three groups were given a set of choices and were asked to select all the types of location-based information they had used to aid their forestry work. The following were the choices:

- ☐ Topographic Map
- ☐ Web Map/ Web Apps
- ☐ Google Earth
- ☐ Harvesting Plan Map
- ☐ VanuaGIS/Vanua View
- ☐ Drones
- ☐ Location description/characteristics/statistics received from a colleague (example, area figure)
- ☐ None

All respondents answered randomly, and the results are analysed are presented in figure 4.2. There was no response recorded for the choice 'None'.

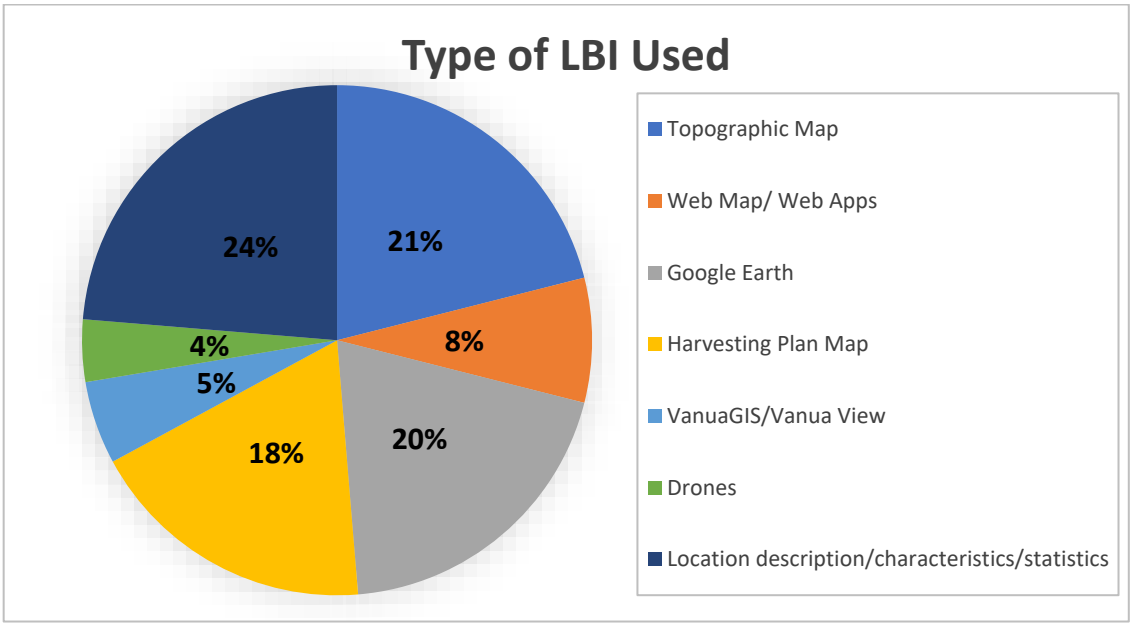


Figure 4. 2 Type of location-based information used to aid works of Foresters.

The above figure summarizes all the responses received for the type of location-based information used based to aid foresters' work. These choices were allocated in the questionnaire based on the personal knowledge of the researcher whereby these are the common types of location-based information

used for Forestry work in Fiji. Topographic map took the highest percentage followed by Google Earth which has recently become a popular source of location-based information (Zhao et al., 2021; Yu and Gong, 2012; Patterson, 2007). VanuaGIS[9] and Drones looked at the lowest percentages. For Vanua GIS, the reason may be due to accessibility issues as it requires user credentials for access[10] which is sought from the Ministry of Lands and is often seen as a hefty process for those officers who do not have a network in that Ministry. Drones is an emerging development in the Ministry of Forestry and its implementation has not been optimized in the whole Ministry, hence it may be the reason that a lot of officers are not able to make use of information derived from drones.

The operation of drones in Forestry also remains a complicated[11] and cost heavy[12] issue due to the risks associated with its operations and its requirements to abide by regulations of national aviation authorities (Mohan et al., 2021; Liang and Delahaye, 2019; Tang and Shao, 2015; Paneque-Gálvez et al., 2014). There are also a lot of limitations to adhere to such as the distance that drones can legally be sent to collect data/information. Mohan et al., (2021), have stated that a lot of aviation laws do not permit beyond visual line of sight operations for drones and wherever it is permitted it does come at a cost.

4.5 Need for location-based information.

These results address the first and second objective of this study which is the importance of locational information and its usage in the forestry sector of Fiji.

[9] A central web map portal used by the Fijian Government which hosts GIS information

[10] However, it is announced to be freely available without requiring user credentials in the Fiji budget 2022-2023 (Budget Estimates 2022-2023, 2022) therefore its use may become more popular.

[11] Requires specialized pilot licensing- and has various levels of training/licensing depending on type of operation required.

[12] Apart from an expensive product itself, a lot of countries require third party limited liability insurance for drone operations (Mohan et al., 2021)

The importance, use and need of location-based information in the Fijian forestry sector is quantified here by its need.

The respondents were given a set of choices and asked for which of those have they needed location-based information. They had the option to choose multiple and could add their own answer as well by choosing 'Other'. The following were the choices based on common usage of location-based information in forestry (Brown, 2004; Baskent and Keles, 2005; Horst, 2006; Nordstom, 2011; Modica et al., 2016; Jaafari, 2017; Meyer, 2017). All the choices got responses which means that one forester or other no matter at what level they were making decisions needed location-based information for one or more of the following:

- Harvesting Planning
- Harvesting Reporting
- Forest Establishment (Tree Planting)
- Planted Areas Monitoring
- Forest Conservation/Protection/Management Planning
- Decision making for policy and planning
- Writing Reports (Scientific/internal/External)
- Harvesting Permissions
- Status update reports
- Other – Forest Certification Planning

Only one response was received for 'Other' option which is stated above. In summary, all the above results conform to studies by Jaafari (2017), Meyer (2017), Modica et al. (2016), Nordstom (2011) Horst (2006), Baskent and Keles (2005) and Brown (2004), which are spread all over the world and have studied the same type of location-based information and its applicability to decision making for forestry. It is no doubt that location-based information plays a particularly vital role in the forest certification process. Kraxner et al., (2017),

Kalonga et al., (2016), Elbakidze et al., (2016), Souza et al., (2005) and Sharifi and Hussin (2004) are some authors who have discussed the use of location-based information in decision making for forest certification. Fiji, having already certified a large part of its softwood plantation forest under Fiji Pine Limited and now working towards certification of its Hardwood products under Fiji Hardwood Cooperation Limited (Dranibaka, 2022; Government of Fiji 2022) will certainly be having location-based information play a crucial role in the decision-making process of forest certification and its implementation. Forest certification is a huge step towards the sustainable development of forests (Elbakidze et al., 2016; Kalonga et al., 2016) and the two largest plantation forest organizations of Fiji being certified whereby location-based information playing a crucial role in certification is an indication of the role that location-based information plays in the sustainable development of Fiji's forests.

From the interviews, there was 100% agreement that location-based information plays a critical role in a forester's daily life for decision making. Researchers support this agreement worldwide (Jaafari, 2017; Meyer, 2017; Modica et al., 2016; Nordstom, 2011; Horst, 2006; Baskent and Keles, 2005; Brown, 2004). There is no surprise in this finding as forests are tied to a spatial location on Earth and making decisions based on where they are located (keeping in mind the features of that particular location) make absolute sense.

4.8 Spatial Information Management Unit

These results address the first and second objective of this study which is the importance of locational information and its usage in the forestry sector of Fiji particularly in the past. **The importance of location-based information here is quantified here by its usage in the past and the evidence of its usage in the past is analysed herein for the second objective of this study.**

Evidence of spatial information exists dating back to 1925-1931 at Ministry (Figure 8).

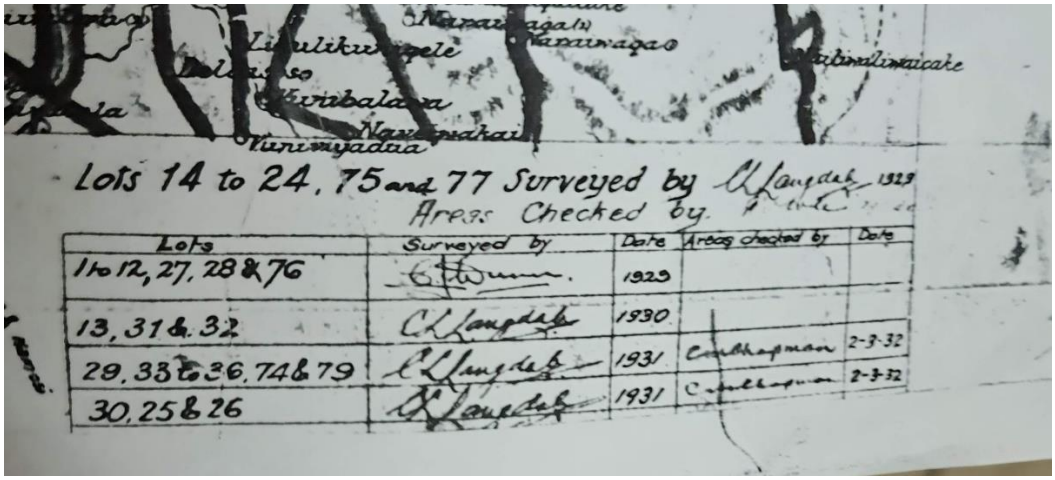


Figure 4.3 A map dating back to 1925-1931 found at the Central/Eastern Division Office of the Ministry (July 2022)

These are maps which were manually plotted and distributed to the operational divisions for their use in decision-making. However, according to Forstreuter (2022), the spatial information management unit at the Ministry was formed in 1991 with assistance from the then GTZ, now known as GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). On the setup of this unit, a lot of satellite imagery analysis and landcover detection exercises took place which is evident from the reports in the PGRSC newsletters of 1993 to 1999. The then GIS and Remote Sensing News newsletter (now known as Pacific GIS Islands GIS and RS Newsletter was born from the Ministry of Forestry in 1993 (Forstreuter, 2022). In the year 1999, the German assistance had run out and the Ministry was left on its own (Forstreuter, 2022; Lewai, 2022). In 2002 the Ministry employed a graduate Geographer for GIS (location-based information) work, who went on through the ranks to leading the Division as Director before resigning in the year 2019 (Lewai, 2022). Apart from this officer there were no qualified graduates of GIS within the Division. All were foresters who developed their GIS knowledge and expertise over time through regional and international trainings sponsored as capacity development (Lewai, 2022). In 2019 there were a total of five officers in the Division who were highly skilled and had experience of ranging from 5 to 10 years each, in the provision of location-based information for forestry decision making to foresters of all levels (Pers. Comm.). However, of the 5, 4 resigned and went on to greener pastures. This

was a massive brain drain for the Division. In late 2018, the Division for the first time hired a graduate GIS Officer. This GIS Officer was not able to take over from the four who left within a brief period from when he was hired (Pers. Comm.). Due to this quick transition in human resource the Division had to start all over again in the systems of location-based information management and provision for decision making.

Together with the loss of human resources, this was also a huge loss of institutional memory. Coffey and Hoffman (2003) have argued that institutional memory loss is a grave issue that may affect an organization's capacity to effectively progress its objectives and prevent repeating mistakes of the past. Institutional memory provides managers and leaders with historical context, which aids in the formation of their visions for the organization's future and comprehension of the context of present activities (McGovern and Samuels, 1998; Coffey and Hoffman, 2003; Lai et al., 2019). It is also true that corporate history may be abused and twisted if institutional memory is not properly preserved. The history of the organization is a significant asset that must be handled correctly. It may be seen as cumulative equity, which symbolizes the attitudes and actions of past and present organizational members accumulated during the organization's existence.

However, a change in human resource structure sometimes helps in substantial progress so that the mentality of “this is how it has always been done” does not exist but new and progressive ways of doing things for better development are adopted. This is a possible scenario of the Ministry of Forestry when things migrated from paper based to web-based technologies for dissemination and use of location-based information in 2019 (Anonymous, 2, 2022).

4.9 Human Resources

These results address the **third objective of this study which is to propose recommendations for the long-term sustainability of location-based information systems in Fiji to aid in sustainable forest management decisions.** Since FRAC is the current unit responsible for collection, collation, storage, analysis, presentation, and dissemination of location-based information in the Ministry, **these results look at where the unit is currently in terms of its human resource capacity.**

Humans are the most important and delicate resources of any organization (Fulmer and Ployhart, 2014). The knowledge, experience, skills, and abilities of the human resource force of an organization can possibly determine and have an impact in the organization's future (Stone et al., 2015).

The human resource capability of utilizing location-based information to make decisions for sustainable forestry within the Ministry is a key factor to be looked at. While there used to be survey sections in the Ministry's operations Divisions in the past, it is possible that professional Cartographers had been employed who would plot locational information on maps (Pers. Comm.). These maps would be manually analysed, and information would be added to it from the field to keep it updated. However, the manual maps are now outdated, and new maps (Figure 4.4) are now produced by GIS specialists for special use cases to make decisions.

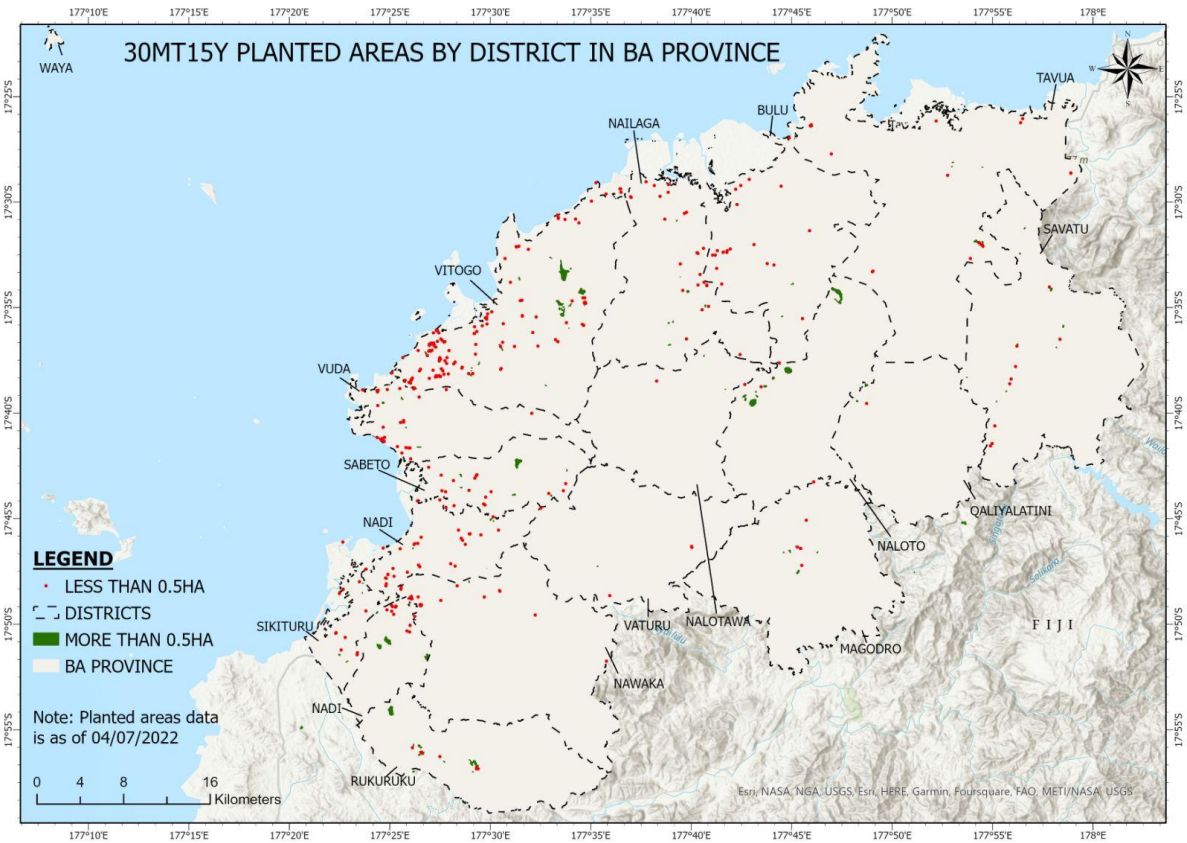


Figure 4. 4 A map created by the GIS Officer of the Ministry which will be used for Divisional planning of the Western Operations Division. (Source: Ministry of Forestry, 2022)

Most of the officers employed by the Ministry are specialized foresters hence they find it difficult to make decisions based on the maps provided to them (Pers. Comm.). Map reading trainings are provided to field officers at least once a year by specialised personnel from the Forest Resource Assessment and Conservation Division (Pers. Comm.). This is in order to keep their skills on map reading fresh as they continue with their specialized forestry work in hand most of the time.

The human resources force of collating[13], storing, analysing, and presenting location-based information is confined at the Forest Resource Assessment and Conservation Division. Currently there are a total of four positions aligned to this specific work which are Senior Resource Assessment and Monitoring Officer, Forestry Officer (GIS), Forester Harvesting and Planning and Forest Guard Mapping (Anonymous, 14, 2022). These officers do all the work of

[13] It is important to note that the role of collecting information lies with every officer of the Ministry.

collating, storing, analysing at their division and disseminate information on a need basis.

4.6 Decentralizing FRAC

These results address to the **third objective of this study which is to propose recommendations for the long-term sustainability of location-based information systems in Fiji to aid in sustainable forest management decisions.** Since FRAC is the current unit responsible for collection, collation, storage, analysis, presentation, and dissemination of location-based information in the Ministry, **these results indicate the best future that the interviewees see for the unit to be sustainable in the Ministry and to serve its purpose in the best capacity.**

The discussion of decentralizing FRAC as a Division and integrating parts of it in the operations Divisions in order to have a more flawless and harmonized flow of location-based information throughout the Ministry also had a 100% agreement and its benefits were put forward by many of the interviewees. Seven interviewees who have been in the Ministry for more than 20years confirmed of the fact that each of the operations division had their own survey team in the 1990s who would derive location-based information from land surveys formal and informal and would use cartographic practices to plot this information on the maps. This information would then be used as criteria in making decisions for forestry. Decisions such as where to plant trees would be made using these maps. In the 1990s these maps helped make decisions where to establish Mahogany and Pine strategically as plantation forests. The same plantation forests which were then planted, aided by decisions made from maps of the time, are now being harvested and generate millions for the Fijian economy today (Anonymous, 15, 2022). The plantations being harvested today also provide employment and livelihoods to the rural dwellers of Fiji who hardly tend to have white collar jobs and will continue to do so in the many years

to come. However, the other side of the coin is that those same decisions if made without proper information on location-based information such as landowner boundaries are becoming to be a trouble for the plantation forestry companies in Fiji. An example is that if a portion for a large plantation falls within different land-owning units and over the years there happens to be a rift in the landowners due to some personal issues, the harvesting operations maybe affected as the landowners start to claim funds for the harvesting operations which may rightfully not belong to them. In the absence of proper location-based information, this is a very delicate issue to solve.

4.7 NFMS

These results address to the **third objective of this study which is to propose recommendations for the long-term sustainability of location-based information systems in Fiji to aid in sustainable forest management decisions.** Since NFMS as a central system collection, collation, storage, analysis, presentation, and dissemination of location-based information in the Ministry already exists, **these results indicate the best future that the interviewees see for the unit to be sustainable in the Ministry and to serve its purpose in the best capacity, keeping in mind whether the NFMS will play a role in the same.**

The National Forest Monitoring System (NFMS) (developed by an external consultant) is already in place, but it is not fully integrated and deployed into the Ministry as of July 2022 (Pers. Comm.). The NFMS is designed in such a way that it harmonises all forestry data into a central system whereby it is collected, collated, stored, manipulated, analysed, presented, and disseminated (Figure 7). The NFMS includes systems of data input and report generation as well.

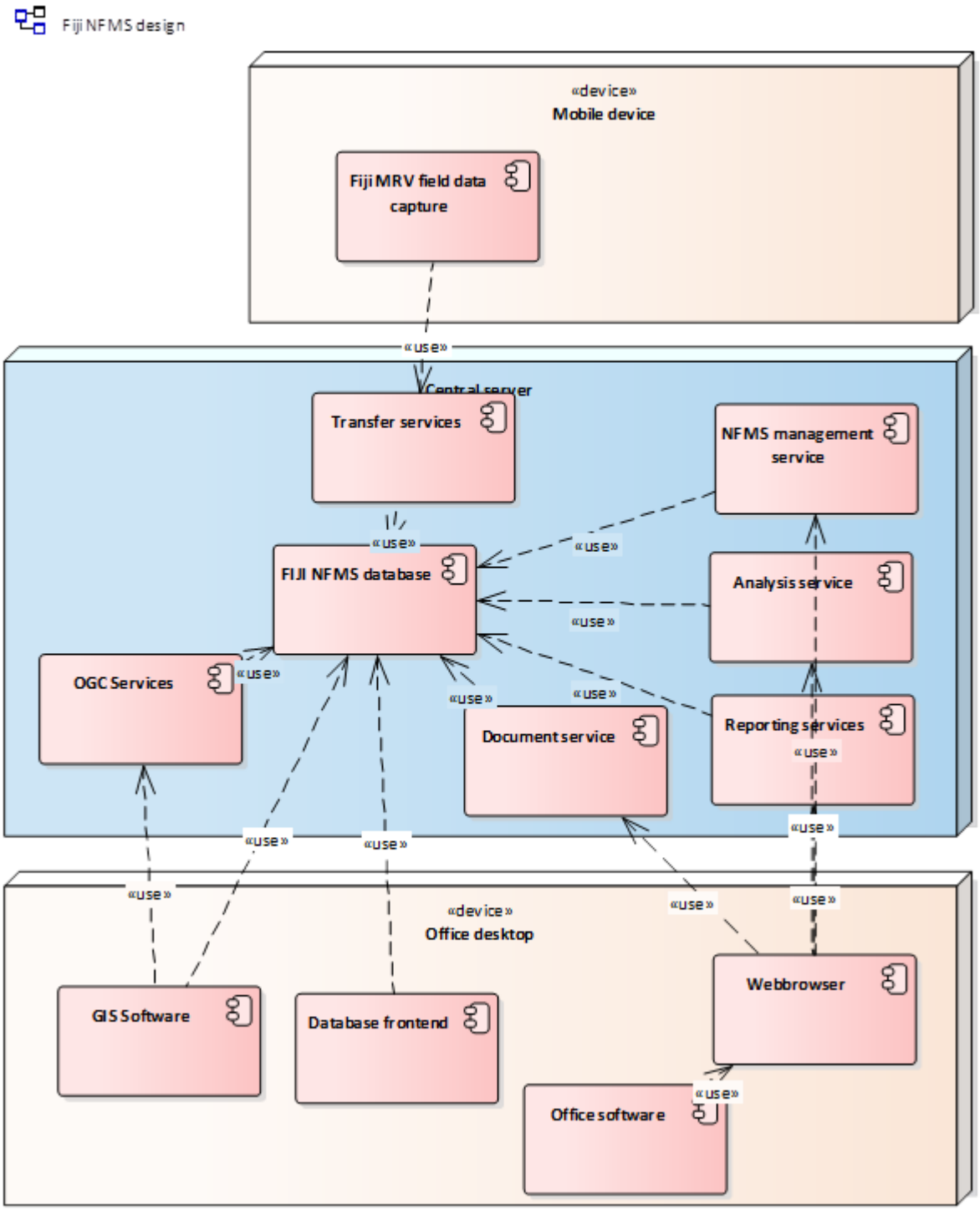


Figure 4.5: NFMS components - Deployment diagram (Source: Ministry of Forestry, 2022)

The NFMS, if comes into play will be the greatest of tool in location-based decision making for sustainable forestry in Fiji (Anonymous, 1, 3, 14, 2022). A lot of the interviewees are not aware of the NFMS in place for the Ministry hence they were not able to present their specific views on it but had general comments. However, five interviewees who were familiar with the NFMS

development had different specific views of it. One interviewee was confident that the NFMS will solve the issues of location-based information, collection, storage, and dissemination. Two interviewees were hopeful that the NFMS **should** solve all problems of data harmonization within the Ministry for decision-making if it operates in its full capacity as per the structure and design of it. One interviewee was (maybe) and the fifth interviewee was of the view that we will have to wait and see once it is operational. There is still a lot of confusion as to when the NFMS will be fully integrated and deployed in the Ministry and a lot of officers are waiting to see the role that NFMS may play in their daily lives. Since the integration and deployment has not been done yet there seems to be a lot of wondering in the air going about. Some officers are hopeful that it will make lives easier, some do not know at all how it will shape their daily work and the others are eager to see how it makes decision making effective, efficient, and quick in their role as foresters. While there is much hope from the NFMS, the conclusion to its role in the current system is that it is still somewhat of a myth for the Ministry, however it is a myth which if comes true may prove to be the most viable solution to all data problems of the day.

4.10 Analysing Locational Information

These results address the second and **third objective of this study which is to propose recommendations for the long-term sustainability of location-based information systems in Fiji to aid in sustainable forest management decisions. These results discuss the analysis component of locational information for current and future usage focusing on software and human resource capability and looks in its future directions.**

One of the most important aspects of using location-based information for decision making is analysing it in order to see its underlying information for decision making (Greene et al., 2011). While it is evident from the survey results that all officers of the Ministry have needed location-based information at one

time or another for their decision making, how much of this information was secondary (analysed) information to gain insight into specific information is unclear. The technical capacity of analysing location-based information using GIS/RS techniques is mostly confined at the Forest Resource Assessment and Conservation Division (Anonymous, 2, 13, 14, 2022). However, the Ministry has initiatives in place to train staff on the use of GIS software. Survey results (Figure 4.6) on staff who have received GIS training while working for the Ministry indicate that 40% staff have had GIS software training while working for the Ministry but a majority 60% have not had any training.

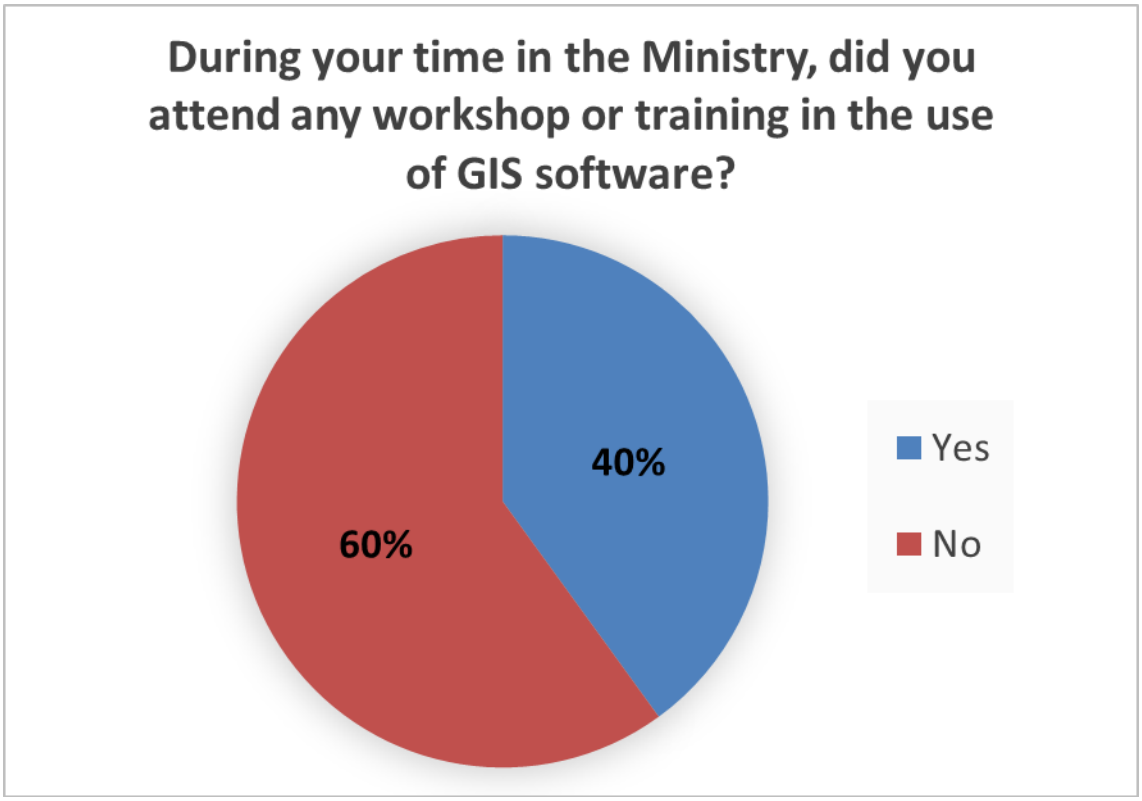


Figure 4. 6 Officers who attended workshops or training in use of GIS software while being employed by the Ministry.

The GIS analyst (Forestry Officer (GIS)) of the Ministry (while being the custodian of all location-based information (Pers. Comm.) is also responsible for analysis and presentation of all location-based information seems like having all eggs in one basket (Pers. Comm.).

Multi criteria decision making using location-based information for forestry as seen in Phua and Minowa (2005), Temiz and Tecim (2009), Greene et al. (2010) and Tahri et al, (2021), has proven to be immensely helpful in making sustainable decisions.

4.11 Technological Capacity

These results answer the **second and third objective** of this study which is to propose **recommendations for the long-term sustainability of location-based information systems in Fiji to aid in sustainable forest management decisions. These results present and discuss the technological capacity of collection, collation, storage, analysis, presentation, and dissemination of locational information for current and future usage focusing on software and human resource capability and looks in its future directions.**

Location based information today has gone digital in the form of Geographic Information Systems. These systems require intensive software and hardware to support their operations. While the Ministry has existing capacity in terms of software and hardware used to collect, collate, analyse, and present location-based information, storage remains a major issue. It has been noted from observation that there is no central storage system for location-based information. A particular noting is that all (4) GIS officers at the Forest Resource Assessment and Conservation Division have their own portable storage devices for storing location-based information. This develops the problem of overlapping work and different versions of information whereby if one officer updates a dataset of information the other will not have a copy of it unless physically supplied with.

4.12 Conclusion

The following can be summarized from the results discussed in this chapter:

1. All Foresters who work towards the sustainable management of Fiji's forests believe that they need location-based information for their decision making.
2. All Foresters who work towards the sustainable management of Fiji's forests use location-based information for their decision making at one point or other.
3. The deployment of Fiji's National Forest Monitoring system, which is to be the hub for forestry location-based information collection, collation, storage, analysis, and presentation is currently bleak.
4. The unit responsible for forestry spatial information management in Fiji has undergone through drastic changes in human resources and its future is bleak.
5. There is a human resource capability gap in proper utilization of location-based information for sustainable forestry decision making.
6. There is a gap in systems of proper, collection, storage, and dissemination of forestry location-based information in Fiji which can possible be filled with the deployment of the National Forest Monitoring System.

CHAPTER 5: RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

Findings of this study were presented and discussed in the last chapter. This chapter presents a recommendation model for the way forward for a sustainable future of using location-based information in Fiji (third objective). It provides recommendations on key aspects to focus on and will conclude by looking at the limitations of this study and future prospective studies.

5.2 Organizational Structure and Human Resources

Having studied the current organizational structure and human resource systems in place for collection, storage, analysis, and dissemination of location-based information it can be concluded that the current organizational structure is not in the best state for smooth organizational process of information collection, storage, analysis, and dissemination for decision making at all levels.

Concentrating the capacity and human resource ability of collection, storage, analysis, and dissemination of location-based information at FRAC is making life difficult for the operational division officers. When they need any of this information to be collected, analysed, and presented or submitted to FRAC they face the technical skills gap where again they have to rely on FRAC for the same. At this instance when they reach out to the FRAC Division for assistance, the FRAC Division treats it as a request and gives it a priority level based on their other deliverables as a Division. This delays the process of locational information access to the Divisional officers and at times due to the complexity of time they end out making decisions based on other criterion other than location.

The operational division officers are the source of all raw location-based information and any policy decision that is made from it falls back on them for implementation. As learnt from the past, it is recommended that FRAC be decentralized, and one specialized skills officer (GIS Officer) be based at each

Operational Division. This officer will act as a point of contact for FRAC for all collection, storage, and dissemination of good quality location-based information to the technical foresters for their informed decision making. This would also ensure that a brain drain at FRAC (as seen in 2018) may not possibly have a direct impact on the operational divisions and they can continue their operations as usual using the location-based information from the GIS Officer based at their division. Another advantage of this arrangement would be the timely flow of information to and from FRAC for the operations division as they would have an in-house technical capability of data collection, storage, and dissemination skills.

The second recommendation is based on the role of FRAC in the Ministry. FRAC acts as a data bank for the Ministry where all data is housed. It is expected that at any point in time any requirement of Forestry data of Fiji should come officially only from FRAC within the Ministry (Anonymous, 2, 3, 4, 9, 13, 14, 15, 2022). Having this in mind, this division cannot be classified as a part of Research and Development but rather something as information services. There is agreement in a lot of officers that FRAC should be part of the Operations Division or report to the Conservator of Forests direct as an Executive Support Division which would provide real time information for critical decision making, most of which is location based and analysed based on its locational characteristics. Hence it is recommended that the role of FRAC in the Ministry be revisited by executive management so as to position it in a way that it serves its rightful purpose under the right authority and guidance without any other influence (Klimach and Pietkiewicz, 2022).

5.3 IT Infrustructure

The current location-based information systems of data collection, collation, analysis, and presentation is comprised of propriety software (ESRI Products).

This incurs an annual subscription fee which falls on the Fijian taxpayer. A transition to open-source software for all of these activities should be made. This will ensure three key things;

1. The burden of the annual subscription will be lifted, and that money can be used elsewhere in a better cause.
2. Since the burden of subscription is lifted, the open-source software will be everlasting as all its functionality and code is on openly available on the internet. This will make the systems future proof and its operations will be easier compared to propriety software which many a times needs specialized training.
3. There will be more control of the system design and functionality locally.

However, open-source software and systems of location information collection, collation, analysis, visualization, and dissemination comes with its set of disadvantages as well. First is that since open-source software is based on open code and relies on coding for its functionality a qualified programmer would be best to set it up and always oversee its smooth operations. The second is the security issues myth tagged to open-source systems which a lot of government organizations tend to veer away from as it puts official government data at risk and poses a security threat to the systems it is operated on for security breaches and data theft. However, with the right security protocols in place security is something which can be assured only to a certain level in either propriety or open source. Security is always a risk; its mitigation should be a priority in this case.

On this note, it should be mentioned that it is best that the National Forest Monitoring System (NFMS) as the central data bank for all Ministry data should be given priority in operations. This system should be enhanced with the latest available technologies. Since the system is already built on open-source software. The NFMS, although built on open-source software and system, is an already approved government system, which will save the hassle of getting

another such open-source system to get approved for use within government operations, hence for it to be operational and integrated into the Ministry's workflow will possibly solve all data flow issues and problems.

5.4 Documentation

The fast-paced development and integration of modern technology into organizations such as the Ministry of Forestry consists of complicated workflows and its long run maintenance requires its in-depth knowledge. Having this in mind, the loss of institutional knowledge can have an impact in the continued operations of such systems. There is little to no documentation currently existing within the Ministry hence the risk of losing the progress when there is a change in human resource remains at extreme prominent levels. It is recommended that thorough documentation be prepared, agreed to, stored, and updated regularly for all workflows regarding the location-based information systems, its collection, storage, collation, analysis, visualization, and dissemination. Haddadpoor et al, (2015) have well described in their paper the role and importance of the documentation process in organizations. Proper documentation will also ensure that a brain drain (like in 2018) will not hinder the organizations progress in the yester years. The documentation will also exist like an institutional memory and will help in learning from the things of past to make informed decisions of the future.

Establishing documentation is not a complicated process. Documentation maintenance (update) and proper storage should be made standard operating procedure for FRAC staff who are the current key human resource for location-based information. The documentation should include the current operating procedure, methodologies and steps used for various processes such as the collection, storage, collation, analysis, visualization, and dissemination of location-based information.

The NFMS has some basic documentation of its structure and operations already which should be used as a guide for documenting all the other operations and workflows in regard to location-based information. From an executive point of view, this documentation will also help track the impact and importance of location-based information which can better shape the decisions regarding the future of such systems.

5.5 Model of Recommendations

to facilitate the practical application of these research findings Table 5.1 shows areas which need attention for a sustainable location-based information system for decision-making. The table also shows priority levels for these areas in the case of Fiji but could be adapted to other environmental fields or locations with some additional desk-based research. High priority areas are ones which need immediate attention, medium priority areas ones which need to be attended to in the next 3 years and low priority areas should be attended to in no less than 5 years. These priority levels are derived from the impact these changes/implementations will have on the system and ensure its long-term sustainability.

Priority Areas	Focus Area	Priority Level for Fiji
Human Resources	1. Ensure that the organizational human resource is qualified with the necessarily knowledge, experience, skills, and abilities to collect, store, collate, analyse, present, and disseminate information.	**Medium**
	2. Ensure that the organization has a planned retaining incentive for human resource with important institutional memory.	**High**
	3. Ensure proper transition arrangements whenever there is a change in human resource.	**Medium**
Organizational Structure	1. Ensure that your organization is structured in a way that your employees work complement each other, and work is distributed as per organizational hierarchy.	**Low**
	2. Ensure that your organization is structured in a way that compliments smooth flow of information is properly planned throughout the organization for effective and efficient decision making.	**High**
Technological Capacity	1. Adapt to open-source systems for long term sustainability.	**Low**
	2. Ensure that information security is given highest priority.	**High**
Documentation	1. Establish a documentation guideline for specialized work.	**Medium**
	2. Make it a standard operating procedure to maintain and update documentation continuously.	**High**

Table 5. 1 Model of Recommendations and its priority levels.

From the research four areas of high priority have been identified while three are of medium priority and two are of low priority. The high priority recommendations will ensure that there is no immediate failure of the system, and it will remain in place with all locational information flowing through the system for use in decision making. The medium and low priority recommendations will ensure that the system remains sustainable in the long run.

This model is designed in such a way that it can be easily adapted to changing needs and technological advancements of this sector in Fiji and can also be applied to any sector in the world which uses location-based information to aid decision making. Sectors which can adopt this model for a sustainable location-based information system are of a long list, but the following is to list a few:

1. Marine Planning
2. Urban Planning
3. Disaster Management
4. Environment Management
5. Land Management
6. Environment Conservation
7. Public Health
8. Water Security

5.5.1 Measuring Implementation of Recommendations

The recommendations stated in the last section can be measured in organization specific ways depending on the dynamics of implementation and adoption of location-based information systems. Table 5.2 shows an example of a way in which the first focus area of the first priority can be measured:

	Attribute	Measurement Criteria	Available? (Yes/No)	Possible Way Forward
Organizational Human Resource	Knowledge	Do employees have the specific knowledge (Education) of the work they are involved in (assigned to) doing?	Yes	Make sure employees attend refresher trainings and are engaged in continuous learning and development.
			No	Reconsider recruitment strategy and introduce incentivised education up taking by employees.
	Experience	Do employees have the required years of experience at the level of work they are doing and the impact it has on the organizational strategies and goals?	Yes	Ensure retainer programs are in place to retain experienced employees.
			No	Assess the impact this will have on the organizations deliverables and re strategize.
	Skills and Abilities	Do employees have the required skills and abilities to undertake the necessary task?	Yes	Ensure retainer programs are in place to retain skilled employees.
			No	Assess the impact this will have on the organizations deliverables and re strategize.

Table 5. 2 Measuring the recommended priority areas.

5.6 Limitations

Some key limitations of this study (apart from the ones already discussed in the methodology) are as follows:

1. The close relation of the researcher with the area of study – while all attempts were made to conduct this study as an academic the possibility of bias in the fact that the researcher is professionally associated with the subject and study area remains. The fact that the researcher can possibly use the findings of this study in shaping the future of this very organization while being its employee could have also impacted and guided some of the findings of this study especially in the semi structured interviews where the researcher could have possibly tried to drive the interviewees in concluding the future of location-based information systems in a way the researcher wants it future to be.
2. Methodology – the methodology in a lot of ways could have been made better should there have been more time. More information could have been collected, properly documented, and analysed as results.

5.7 Conclusion

The outcomes of the study have met all the objectives set in the beginning of this study with the possible limitations as identified in the previous section of this chapter. However, a summary of the outcomes of the objectives are presented in table 5.3 below:

Objectives	Outcomes
Establish the importance of locational information in decision making for forest management and its contribution towards sustainable forest management.	There is significant evidence that location-based information has played an important role in decision making for sustainable forest management. This is true for all levels of decision making, right from a forester in the field to an executive law maker of the country.
Study the present and past use of location-based information in the Fijian forestry sector.	Evidence of location-based information being used in the Fijian forestry sector is available dating back to 1925. However, the past and present of location-based information in the Fijian forestry sector has significant differences and there needs to be an changes put in place for a sustainable future.
Propose recommendations model for the long-term sustainability of location-based information systems in Fiji to aid in sustainable forest management decisions.	Recommendations of best practice based on research and evidence from around the world have been made in the last chapter- for the spatial information management unit for providing continued decent quality location-based information to make sustainable forestry decisions.

Table 5. 3 Objectives and outcomes of this study.

5.8 Future Studies

Future studies can focus on narrowing down these objectives and quantifying the impact that location-based information makes in making sustainable decisions for forestry. It should establish the importance of location-based information, the type of information needed and how it is being used to make what types of decisions in forestry sectors. It can also establish the difference between decisions which are made by using location-based information and the decisions which are omitting location-based information as a criterion in decision making. Its impact on sustainable development should also be measured and recommendations for best practice be made. Table 5.4 shows details of a few future studies which could be undertaken.

Topic	Brief of Recommended Study	Recommended Time Length of Study
Implications of not using location-based information on sustainable development.	The effect that decisions which are made without considering spatial information will have on sustainable development. Focus on a sector which is associated with fighting climate change such as Forests.	3–5-year PhD
Investigation of the role location-based information plays in measuring sustainable development	Investigate the role that location-based information plays in measuring the sustainable development goals.	Depending on area of study - A country – 1year Masters in Research - A Region – 3–5-year PhD
Role of Open-Source Software in making informed location-based decisions.	Study how open-source software compliments decision makers at no cost being an essential aid to their decision making.	3 – 6 months of Masters Dissertation.

Table 5.4 Details of Future studies which could be undertaken.

REFERENCES

15.2.1 Progress Towards Sustainable Forest Management.
Available: https://sdg.tracking-progress.org/indicator/15-2-1-progress-towards-sustainable-forest-management/ [Feb 3, 2022].

Ahmadi Sani, N., Babaie Kafaky, S., Pukkala, T. and Mataji, A. (2016). Integrated Use of GIS, Remote Sensing and Multi-Criteria Decision Analysis to Assess Ecological Land Suitability in Multi-Functional Forestry. Journal of Forestry Research, 27(5), Pp. 1127-1135.

Arabameri, A., Pradhan, B., Pourghasemi, H.R. and Rezaei, K. (2018). Identification of Erosion-Prone Areas Using Different Multi-Criteria Decision-Making Techniques and GIS. Null, 9(1), Pp. 1129-1155.

Aras, G. and Crowther, D. (2009). Making Sustainable Development Sustainable. Management Decision, 47(6), Pp. 975-988.

Argote, L. and Guo, J.M. (2016). Routines and Transactive Memory Systems: Creating, Coordinating, Retaining, and Transferring Knowledge in Organizations. Research in Organizational Behavior, 36, Pp. 65-84.

Armada, N., White, A.T. and Christie, P. (2009). Managing Fisheries Resources in Danajon Bank, Bohol, Philippines: An Ecosystem-Based Approach. Null, 37(3-4), Pp. 308-330.

Bandura, A. (2006). Toward a Psychology of Human Agency. Perspectives on Psychological Science, 1(2), 164–180. https://doi.org/10.1111/j.1745-6916.2006.00011.x

Bansal, V.K., (2020). Use of GIS to Consider Spatial Aspects in Construction Planning Process. Null, 20(3), Pp. 207-222.

Baskent, E.Z. and Keles, S. (2005). Spatial Forest Planning: A Review. Ecological Modelling, 188(2), Pp. 145-173.

Bernthal, P. R., & Wellins, R. S. (2001). Retaining talent: A benchmarking study. HR Benchmark Group, 2(3), 1-28.

Blicharska, M., Angelstam, P., Giessen, L., Hilszczański, J., Hermanowicz, E., Holeksa, J., Jacobsen, J.B., Jaroszewicz, B., Konczal, A., Konieczny, A., Mikusiński, G., Mirek, Z., Mohren, F., Muys, B., Niedziałkowski, K., Sotirov, M., Stereńczak, K., Szwagrzyk, J., Winder, G.M., Witkowski, Z., Zaplata, R. and Winkel, G. (2020) Between biodiversity conservation and sustainable forest management – A multidisciplinary assessment of the emblematic Białowieża Forest case. Biological Conservation, 248, pp. 108614.

Bolis, I., Morioka, S.N. and Sznelwar, L.I. (2017). Are We Making Decisions in A Sustainable Way? A Comprehensive Literature Review About Rationalities for Sustainable Development. Journal of Cleaner Production, 145, Pp. 310-322.

Bonan, G.B., (2008). Forests and Climate Change: Forcings, Feedbacks, and The Climate Benefits of Forests. Science, 320(5882), Pp. 1444-1449.

Breidenbach, J., Mcroberts, R.E., Alberdi, I., Antón-Fernández, C. and Tomppo, E. (2021). A Century of National Forest Inventories – Informing Past, Present and Future Decisions. Forest Ecosystems, 8(1), Pp. 36.

Brown, G., (2004). Mapping Spatial Attributes in Survey Research for Natural Resource Management: Methods and Applications. Null, 18(1), Pp. 17-39.

Brynjolfsson, E. and Hitt, L.M. (2000). Beyond Computation: Information Technology, Organizational Transformation and Business Performance. Journal of Economic Perspectives, 14(4), Pp. 23-48.

Budget Estimates 2022-2023. Republic of Fiji. as Presented to Parliament – 15th July 2022. Accessible: https://www.economy.gov.fj/images/Budget/budgetdocuments/estimates/Budget_/Estimates_2022-2023.pdf Accessed: 17/07/2022

Burt, B. and Clerk, C. (1997). Environment and Development in The Pacific Islands: Introduction. Environment and Development in The Pacific Islands, 25, Pp. 1.

Câmara, G., Vinhas, L., Davis, C., Fonseca, F. and Carneiro, T., 2009. Geographical Information Engineering in the 21 St Century. Research Trends in Geographic Information Science. Springer, Pp. 203-218.

Campling, L. and Rosalie, M. (2006). Sustaining Social Development in A Small Island Developing State? The Case of Seychelles. Sustainable Development, 14(2), Pp. 115-125.

Canadell, J.G. and Raupach, M.R. (2008). Managing Forests for Climate Change Mitigation. Science, 320(5882), Pp. 1456-1457.

Cappelli, P. (2000). A market-driven approach to retaining talent. Harvard business review, 78(1), 103-111.

Cappelli, P. (2008). Talent management for the twenty-first century. Harvard business review, 86(3), 74.

Carlsen, L. and Bruggemann, R. (2022). The 17 United Nations' Sustainable Development Goals: A Status By 2020. International Journal of Sustainable Development & World Ecology, 29(3), Pp. 219-229.

Chichilnisky, G., (1997). What Is Sustainable Development? Land Economics, 73(4), Pp. 467-491.

Chris Parsons (2007) Web-Based Surveys: Best Practices Based on the Research Literature, Visitor Studies, 10:1, 13-33, DOI: 10.1080/10645570701263404

Coffey, J.W. and Hoffman, R.R. (2003). Knowledge Modelling for The Preservation of Institutional Memory. Journal of Knowledge Management, 7(3), Pp. 38-52.

Collings, D.G., (2014). The Contribution of Talent Management to Organization Success. The Wiley Blackwell Handbook of The Psychology of Training, Development, and Performance Improvement, Pp. 247-260.

Conroy, M.J. and Peterson, J.T., 2013. Decision Making in Natural Resource Management: A Structured, Adaptive Approach. John Wiley & Sons.

Crossland M. (2008) Decision-Making Effectiveness with GIS. in: Shekhar S., Xiong H. (eds) Encyclopedia of GIS. Springer, Boston, MA.

D'Amico G, Vangi E, Francini S, Giannetti F, Nicolaci A, Travaglini D, Massai L, Giambastiani Y, Terranova C, Chirici G (2021). Are we ready for a National Forest Information System? State of the art of forest maps and airborne laser scanning data availability in Italy. iForest 14: 144-154. - doi: 10.3832/ifor3648-014

Damoom, M.M., Hashim, S., Aljohani, M.S., Saleh, M.A. and Xoubi, N. (2019). Potential Areas for Nuclear Power Plants Siting in Saudi Arabia: GIS-Based Multi-Criteria Decision-Making Analysis. Progress in Nuclear Energy, 110, Pp. 110-120.

Dean, James W., JR and Shafman, M.P., 1996. Does decision process matter? A study of strategic decision-making effectiveness. Academy of Management Journal, **39**(2), pp. 368.

Delgado López-Cózar, E., Orduña-Malea, E. and Martín-Martín, A., 2019. Google Scholar as a Data Source for Research Assessment. in: W. Glänzel, H.F. Moed, U. Schmoch and M. Thelwall, Eds, Springer Handbook of Science and Technology Indicators. Cham: Springer International Publishing, Pp. 95-127.

Dernbach, J.C., (2003). Achieving Sustainable Development: The Centrality and Multiple Facets of Integrated Decisionmaking. Indiana Journal of Global Legal Studies, 10(1), Pp. 247-284.

DFAT. (2021) Tropical Cyclone Yasa [Homepage of Australian Govt - Department of Foreign Affairs and Trade], [Online]. Available: https://www.dfat.gov.au/crisis-hub/tropical-cyclone-yasa [Feb 4, 2022].

Di Piazza, A., Di Piazza, M. C., Ragusa, A., & Vitale, G. (2011). Environmental data processing by clustering methods for energy forecast and planning. Renewable energy, 36(3), 1063-1074.

Docquier, F., Lohest, O., & Marfouk, A. (2007). Brain drain in developing countries. The World Bank Economic Review, 21(2), 193-218.

Dos Santos, P.H., Neves, S.M., Sant'anna, D.O., Oliveira, C.H.D. and Carvalho, H.D. (2019). The Analytic Hierarchy Process Supporting Decision Making for Sustainable Development: An Overview of Applications. Journal of Cleaner Production, 212, Pp. 119-138.

Dubos, R., Cooper, J., & Mechanic, D. (1998). So, Human an Animal: How We are Shaped by Surroundings and Events (1st ed.). Routledge. https://doi.org/10.4324/9781315129396

Durduran, S.S., (2010). A Decision-Making System to Automatic Recognize of Traffic Accidents on The Basis of A GIS Platform. Expert Systems with Applications, 37(12), Pp. 7729-7736.

Economic and Fiscal Update Supplement to the 2022-2023 Budget Address. Ministry of Economy, Republic of Fiji. (2022). Accessible: https://www.economy.gov.fj/images/Budget/budgetdocuments/supplements/2022-2023_Budget_Supplement_final.pdf Accessed: 17/07/2022

Eisenmenger, N., Pichler, M., Krenmayr, N., Noll, D., Plank, B., Schalmann, E., Wandl, M. and Gingrich, S. (2020). The Sustainable Development Goals Prioritize Economic Growth Over Sustainable Resource Use: A Critical Reflection on The SDGs from A Socio-Ecological Perspective. Sustainability Science, 15(4), Pp. 1101-1110.

e-Journal of Business Education and Scholarship of Teaching, v8 n2 p54-68

El Sawy, O.A., Gomes, G.M. and Gonzalez, M.V. (1986). Preserving Institutional Memory: The Management of History as An Organizational Resource. Proceedings, 1986(1), Pp. 118-122.

Elbakidze, M., Ražauskaitė, R., Manton, M., Angelstam, P., Mozgeris, G., Brūmelis, G., Brazaitis, G. and Vogt, P. (2016). The Role of Forest Certification for Biodiversity Conservation: Lithuania as A Case Study. European Journal of Forest Research, 135(2), Pp. 361-376.

Elbeck, Matt. (2014). Selecting a Free Web-Hosted Survey Tool for Student Use,

Espey, J. Using evidence & data to drive action on the SDGs. SDSN http://unsdsn.org/news/2018/06/28/using-evidence-data-to-drive-action-on-the-sdgs/ (2018)

Feeney, M., Rajabifard, A. & Williamson, I. P. (2001). Spatial data infrastructure frameworks to support decision-making for sustainable development. Proceedings of the 5th Global Spatial Data Infrastructures, pp.1-15. Geography Institute of Colombia. https://doi.org/10.1007/978-0-387-35973-1_271

Fonseca, F., Davis, C.A. and Câmara, G. (2009). Spatial Data Infrastructures for The Amazon: A First Step Towards A Global Forest Information System. Earth Science Informatics, 2(4), Pp. 189.

Food and Agriculture Organization of The United Nations, 2020a-Last Update, The State of The World's Forests 2020. Available: Http://Www.Fao.Org/State-of-Forests/En/ [Aug 10, 2022].

Food and Agriculture Organization of The United Nations, 2020b-Last Update, Sustainable Forest Management.
Available: Https://Www.Fao.Org/Forestry/Sfm/En/ [11/02/, 2022].

Food and Agriculture Organization of The United Nations, Sustainable Forest management. Available: https://www.fao.org/forestry/sfm/en/ [Feb 11, 2022].

Forstreuter, W. (2022) Interview with Mohammed Shorab, 24 January.

Fosso Wamba, S., Akter, S., Edwards, A., Chopin, G. and Gnanzou, D. (2015). How 'Big Data' Can Make Big Impact: Findings from A Systematic Review and A Longitudinal Case Study. International Journal of Production Economics, 165, Pp. 234-246.

Fulmer, I.S. and Ployhart, R.E. (2014). "Our Most Important Asset" A Multidisciplinary/Multilevel Review of Human Capital Valuation for Research and Practice. Journal of Management, 40(1), Pp. 161-192.

Gardiner, B.A. and Quine, C.P. (2000). Management of Forests to Reduce the Risk of Abiotic Damage — A Review With Particular Reference to The Effects of Strong Winds. Forest Ecology and Management, 135(1), Pp. 261-277.

Gardner, J.E., (1989). Decision Making for Sustainable Development: Selected Approaches to Environmental Assessment and Management. Environmental Impact Assessment Review, 9(4), Pp. 337-366.

Geneletti, D. (2019). Multicriteria Analysis for Environmental Decision-Making. Anthem Press.

Gershunskaya, J.B., 2011. Treatment of Influential Observations in The Current Employment Statistics Survey. University of Maryland, College Park.

Goodchild, M.F., (1987). A Spatial Analytical Perspective on Geographical Information Systems. International Journal of Geographical Information System, 1(4), Pp. 327-334.

Gough, A.D., Innes, J.L. and Allen, S.D. (2008). Development of Common Indicators of Sustainable Forest Management. Ecological Indicators, 8(5), Pp. 425-430.

Greene, R., Devillers, R., Luther, J.E. and Eddy, B.G. (2011). GIS-Based Multiple-Criteria Decision Analysis. Geography Compass, 5(6), Pp. 412-432.

Greene, R., Luther, J.E., Devillers, R. and Eddy, B. (2010). An Approach to GIS-Based Multiple Criteria Decision Analysis That Integrates Exploration and Evaluation Phases: Case Study in A Forest-Dominated Landscape. Forest Ecology and Management, 260(12), Pp. 2102-2114.

Greenlaw, C., & Brown-Welty, S. (2009). A Comparison of Web-Based and Paper-Based Survey Methods: Testing Assumptions of Survey Mode and Response Cost. Evaluation Review, 33(5), 464–480. https://doi.org/10.1177/0193841X09340214

Gregory, R., Failing, L., Harstone, M., Long, G., Mcdaniels, T. and Ohlson, D., 2012. Structured Decision Making: A Practical Guide to Environmental Management Choices. John Wiley & Sons.

Haddadpoor, A., Taheri, B., Nasri, M., Heydari, K., & Bahrami, G. (2015). Process Documentation: A Model for Knowledge Management in Organizations. Materia socio-medica, 27(5), 347–350. https://doi.org/10.5455/msm.2015.27.347-350

Haddaway NR, Collins AM, Coughlin D, Kirk S (2015) The Role of Google Scholar in Evidence Reviews and Its Applicability to Grey Literature Searching. PLoS ONE 10(9): e0138237. https://doi.org/10.1371/journal.pone.0138237

Hagbaghery, M.A., Salsali, M. and Ahmadi, F. (2004). The Factors Facilitating and Inhibiting Effective Clinical Decision-Making in Nursing: A Qualitative Study. Bmc Nursing, 3(1), Pp. 2.

Hägglund, A.E. and Leuze, K. (2021). Gender Differences in Stem Expectations Across Countries: How Perceived Labor Market Structures Shape Adolescents' Preferences. Null, 24(5), Pp. 634-654.

Halevi, G., Moed, H. and Bar-Ilan, J. (2017). Suitability of Google Scholar as A Source of Scientific Information and as A Source of Data for Scientific Evaluation—Review of The Literature. Journal of Informetrics, 11(3), Pp. 823-834.

Hansda, R., (2009). The Outlook for Non-Wood Forest Products in Asia and The Pacific. Asia-Pacific Forestry Sector Outlook Study Ii Working Paper Series, 89.

Hara, K., Kitakaji, Y., Sugino, H., Yoshioka, R., Takeda, H., Hizen, Y. and Saijo, T. (2021). Effects of Experiencing the Role of Imaginary Future Generations in Decision-Making: A Case Study of Participatory Deliberation in A Japanese Town. Sustainability Science, 16(3), Pp. 1001-1016.

Hartung, A., Wessling, K. and Hillmert, S. (2022). Interplay Between Family Background and Labour-Market Conditions in Shaping Students' Occupational Status Expectations. Null, 35(4), Pp. 405-421.

Heintze, T. and Bretschneider, S. (2000). Information Technology and Restructuring in Public Organizations: Does Adoption of Information Technology Affect Organizational Structures, Communications, and Decision Making? Journal of Public Administration Research and Theory, 10(4), Pp. 801-830.

Helsel, D. R. (2011). Statistics for censored environmental data using Minitab and R (Vol. 77). John Wiley & Sons.

Hertel, G., Niedner, S. and Herrmann, S. (2003). Motivation of Software Developers in Open-Source Projects: An Internet-Based Survey of Contributors to The Linux Kernel. Research Policy, 32(7), Pp. 1159-1177.

Hladik, C. M., Linares, O. F., Hladik, A., Pagezy, H., & Semple, A. (1993). Tropical forests, people and food: an overview. Tropical Forests, People and Food: Biocultural interactions and applications to development, 3-14.

Hongal, P. and Kinange, U. (2020). A Study on Talent Management and Its Impact on Organization Performance-An Empirical Review. International Journal of Engineering and Management Research, 10.

Horbiński T, Cybulski P, Medyńska-Gulij B. (2021) Web Map Effectiveness in the Responsive Context of the Graphical User Interface. ISPRS International Journal of Geo-Information. https://doi.org/10.3390/ijgi10030134

Horváthová, P., 2011the Application of Talent Management At Human Resource Management in Organization, 3rd International Conference on Information and Financial Engineering, Ipedr 2011, Pp. 50-54.

http://gisconference.gsd.spc.int/presentations_2015/Day2/session1/PacGIS_RS_2015_D2S1_Century_Fiji_Forestry.pdf

Huber, G. P. (1990). A theory of the effects of advanced information technologie. Academy of Management.the Academy of Management Review, 15(1), 47. Retrieved from https://www.proquest.com/scholarly-journals/theory-effects-advanced-information-technologie/docview/210937018/se-2

Ilieva, J., Baron, S., & Healey, N. M. (2002). Online Surveys in Marketing Research. International Journal of Market Research, 44(3), 1–14. https://doi.org/10.1177/147078530204400303

Ishtiaque A, Masrur A, Rabby YW, Jerin T, Dewan A. (2020) Remote Sensing-Based Research for Monitoring Progress towards SDG 15 in Bangladesh: A Review. Remote Sensing. 12(4):691. https://doi.org/10.3390/rs12040691

Islam, M.S. and Wahab, M.A., 2005. A Review on The Present Status and Management of Mangrove Wetland Habitat Resources in Bangladesh With Emphasis on Mangrove Fisheries and Aquaculture. in: H. Segers and K. Martens, Eds, Aquatic Biodiversity Ii. Dordrecht: Springer Netherlands, Pp. 165-190.

Jaafari A., Rezaeian J., Omrani M.S. (2017). Spatial Prediction of Slope Failures in Support of Forestry Operations Safety. Croatian Journal of Forest Engineering: Journal for Theory and Application of Forestry Engineering, Vol. 38 No. 1. https://hrcak.srce.hr/en/file/257417

Jabareen, Y., (2008). A New Conceptual Framework for Sustainable Development. Environment, Development and Sustainability, 10(2), Pp. 179-192.

Janssen, R. and Uran, O. (2003) Presentation of information for spatial decision support A survey on the use of maps by participants in quantitative water management in the IJsselmeer region, The Netherlands. Physics and Chemistry of the Earth, Parts A/B/C, 28(14), pp. 611-620.

Janssen, R. and Uran, O. (2003). Presentation of Information for Spatial Decision Support A Survey on The Use of Maps by Participants in Quantitative Water Management in The Ijsselmeer Region, The Netherlands. Physics and Chemistry of The Earth, Parts A/B/C, 28(14), Pp. 611-620.

Jeong, J.S. (2018) Design of spatial PGIS-MCDA-based land assessment planning for identifying sustainable land-use adaptation priorities for climate change impacts. Agricultural Systems, 167, pp. 61-71.

Jeong, J.S., (2018). Design of Spatial PGIS-Mcda-Based Land Assessment Planning for Identifying Sustainable Land-Use Adaptation Priorities for Climate Change Impacts. Agricultural Systems, 167, Pp. 61-71.

Jingling, L., Yun, L., Liya, S., Zhiguo, C. and Baoqiang, Z. (2010). Public Participation in Water Resources Management of Haihe River Basin, China: The Analysis and Evaluation of Status Quo. Procedia Environmental Sciences, 2, Pp. 1750-1758.

John Joseph and Vibha Gaba

Jon Michael Swain, & Spire, Z. D. (2020). The role of informal conversations in generating data, and the ethical and methodological issues. Forum: Qualitative Social Research, 21(1)https://doi.org/10.17169/fqs-21.1.3344

Jørgensen, S. E. (Ed.). (2013). Handbook of Environmental Data and Ecological Parameters: Environmental Sciences and Applications (Vol. 6). Elsevier.

Julca, A. and Paddison, O. (2010). Vulnerabilities and Migration in Small Island Developing States in The Context of Climate Change. Natural Hazards, 55(3), Pp. 717-728.

Kalonga, S.K., Midtgaard, F. and Klanderud, K. (2016). Forest Certification as A Policy Option in Conserving Biodiversity: An Empirical Study of Forest Management in Tanzania. Forest Ecology and Management, 361, Pp. 1-12.

Kawulich, B. B. (2005). Participant Observation as a Data Collection Method. Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 6(2). https://doi.org/10.17169/fqs-6.2.466

Keenan, P.B. and Jankowski, P. (2019) Spatial Decision Support Systems: Three decades on. Decision Support Systems, 116, pp. 64-76.

Keenan, P.B. and Jankowski, P. (2019). Spatial Decision Support Systems: Three Decades on. Decision Support Systems, 116, Pp. 64-76.

Kienast, F., Bolliger, J., Potschin, M., De Groot, R. S., Verburg, P. H., Heller, I., ... & Haines-Young, R. (2009). Assessing landscape functions with broad-scale environmental data: insights gained from a prototype development for Europe. Environmental management, 44(6), 1099-1120.

Klimach, A. and Pietkiewicz, M. (2022). Utility of The Forest Data Bank for Forest Management – Polish Case Study and Legal Analysis. Null, 37(1), Pp. 83-91.

Kost, R. G., & de Rosa, J. C. (2018). Impact of survey length and compensation on validity, reliability, and sample characteristics for Ultrashort-, Short-, and Long-Research Participant Perception Surveys. Journal of clinical and translational science, 2(1), 31–37. https://doi.org/10.1017/cts.2018.18

Kozak, K. H., Graham, C. H., & Wiens, J. J. (2008). Integrating GIS-based environmental data into evolutionary biology. Trends in ecology & evolution, 23(3), 141-148.

Kraxner, F., Schepaschenko, D., Fuss, S., Lunnan, A., Kindermann, G., Aoki, K., Dürauer, M., Shvidenko, A. and See, L. (2017). Mapping Certified Forests for Sustainable Management - A Global Tool for Information Improvement Through Participatory and Collaborative Mapping. Forest Policy and Economics, 83, Pp. 10-18.

Kuhn, W., (2012). Core Concepts of Spatial Information for Transdisciplinary Research. Null, 26(12), Pp. 2267-2276.

Kumari, R., & Nakano, Y. (2016). Does land lease tenure insecurity cause decreased productivity and investment in the sugar industry? Evidence from Fiji. Australian Journal of Agricultural and Resource Economics, 60(3), 406-421.

Kurttila, M., (2001). The Spatial Structure of Forests in The Optimization Calculations of Forest Planning — A Landscape Ecological Perspective. Forest Ecology and Management, 142(1), Pp. 129-142.

Lai, L.W.C., Chau, K.W. and Lorne, F.T. (2019). “Forgetting By Not Doing”: An Institutional Memory Inquiry of Forward Planning for Land Production by Reclamation. Land Use Policy, 82, Pp. 796-806.

Lawrence, B.S., (1984). Historical Perspective: Using the Past to Study the Present. Amr, 9(2), Pp. 307-312.

Lemprière, T.C., Kurz, W.A., Hogg, E.H., Schmoll, C., Rampley, G.J., Yemshanov, D., Mckenney, D.W., Gilsenan, R., Beatch, A., Blain, D., Bhatti, J.S. and Krcmar, E. (2013). Canadian Boreal Forests and Climate Change Mitigation. Environmental Reviews, 21(4), Pp. 293-321.

Lewai, A. (2022) Interview with Mohammed Shorab, 31 January.

Liang, M. and Delahaye, D., 2019drone Fleet Deployment Strategy for Large Scale Agriculture and Forestry Surveying, 2019, Pp. 4495-4500.

Lindenmayer, D.B., Margules, C.R. and Botkin, D.B. (2000). Indicators of Biodiversity for Ecologically Sustainable Forest Management. Conservation Biology, 14(4), Pp. 941-950.

Liu, S., Bai, J. and Chen, J. (2019) Measuring SDG 15 at the County Scale: Localisation and Practice of SDGs Indicators Based on Geospatial Information, ISPRS international journal of geo-information, 8(11), p. 515–. doi:10.3390/ijgi8110515.

Liu, Y., Gupta, H., Springer, E. and Wagener, T. (2008). Linking Science with Environmental Decision Making: Experiences From An Integrated Modeling Approach to Supporting Sustainable Water Resources Management. Environmental Modelling & Software, 23(7), Pp. 846-858.

Macdicken, K.G., Sola, P., Hall, J.E., Sabogal, C., Tadoum, M. and De Wasseige, C. (2015). Global Progress Toward Sustainable Forest Management. Forest Ecology and Management, 352, Pp. 47-56.

Macura, B., Suškevičs, M., Garside, R., Hannes, K., Rees, R. and Rodela, R. (2019) Systematic reviews of qualitative evidence for environmental policy and management: an overview of different methodological options. Environmental evidence, 8(1), pp. 24.

Macura, B., Suškevičs, M., Garside, R., Hannes, K., Rees, R. and Rodela, R. (2019). Systematic Reviews of Qualitative Evidence for Environmental Policy and Management: An Overview of Different Methodological Options. Environmental Evidence, 8(1), Pp. 24.

Marshall, B., Cardon, P., Poddar, A. and Fontenot, R. (2013). Does Sample Size Matter in Qualitative Research? A Review of Qualitative Interviews in Is Research. Null, 54(1), Pp. 11-22.

Martín-García, J., Diez J. (2012) Sustainable Forest Management: An Introduction and Overview, in J. M. Garcia, J. J. Diez (eds.), Sustainable Forest Management - Current Research, IntechOpen, London. 10.5772/45839.

Mcdonald, G.T. and Lane, M.B. (2004). Converging Global Indicators for Sustainable Forest Management. Forest Policy and Economics, 6(1), Pp. 63-70.

Mcgovern, T.J. and Samuels, H.W. (1998). Our Institutional Memory At Risk: Collaborators to The Rescue. Campus-Wide Information Systems, 15(3), Pp. 103-107.

Meyer, M. A., & Schulz, C. (2017). Do ecosystem services provide an added value compared to existing forest planning approaches in Central Europe? Ecology and Society, 22(3). http://www.jstor.org/stable/26270148

Michaels, E., Handfield-Jones, H. and Axelrod, B., 2001. The War for Talent. Harvard Business Press.

Mikusiński, G. and Niedziałkowski, K. (2020). Perceived Importance of Ecosystem Services in The Białowieża Forest for Local Communities – Does Proximity Matter? Land Use Policy, 97, Pp. 104667.

Ministry of Fisheries & Forests (2007) Fiji Forest Policy Statement. Suva: Government of the Republic of Fiji Islands.

Ministry of Forestry. (2021). Annual Report 2018-2019. Available: https://www.parliament.gov.fj/wp-content/uploads/2021/12/178-Ministry-of-Forestry-Annual-Report-2018%E2%80%932019.pdf Accessed: 10/08/2022

Mitlin, D., (1992). Sustainable Development: A Guide to The Literature. Environment and Urbanization, 4(1), Pp. 111-124.

Modica, G., Pollino, M., Lanucara, S., La Porta, L., Pellicone, G., Di Fazio, S. and Fichera, C.R., 2016land Suitability Evaluation for Agro-Forestry: Definition of A Web-Based Multi-Criteria Spatial Decision Support System (Mc-Sdss): Preliminary Results, O. Gervasi, B. Murgante, S. Misra, Rocha, Ana Maria A. C., C.M. Torre, D. Taniar, B.O. Apduhan, E. Stankova and S. Wang, Eds. in: Computational Science and Its Applications -- Iccsa 20, 16 2016, Springer International Publishing, Pp. 399-413.

Mohan, M.,Richardson, G.,Gopan, G.,Aghai, M.M.,Bajaj, S.,Galgamuwa, G.A.P.,Vastaranta, M.,Arachchige, P.S.P.,Amorós, L.,Corte, A.P.,De-Miguel, S.,Leite, R.V.,Kganyago, M.,Broadbent, E.N.,Doaemo, W.,Shorab, M.A. and Cardil, A.,.(2021). Uav-Supported Forest Regeneration: Current Trends, Challenges and Implications.

Mueller-Dombois, D. and Fosberg, F.R., 2013. Vegetation of The Tropical Pacific Islands. Springer Science & Business Media.

National Conference on GIS Research UK, Andrew A. Lovett, and Katy Appleton. (2008) GIS for environmental decision-making. Boca Raton: CRC Press.

Neykov, N.,Krišťáková, S.,Hajdúchová, I.,Sedliačiková, M.,Antov, P. and Giertliová, B.,.(2021). Economic Efficiency of Forest Enterprises—Empirical Study Based on Data Envelopment Analysis.

Ngoma, A. L., & Ismail, N. W. (2013). The determinants of brain drain in developing countries. International Journal of Social Economics, 40(8), 744-754.

Nordström, Eva-Maria, Eriksson, Ola L., Karin and Öhman. (2011). Multiple criteria decision analysis with consideration to place-specific values in participatory forest planning. Silva Fennica. 45 :2, 253–265 [Research article]

Oladele, A., (2002). Sustainable Development Policy. African Studies Review, 50(1), Pp. 210-221.

Organizational Structure, Information Processing, and Decision-Making: A Retrospective and Road Map for Research

Ostrom, E. (2005). Self-governance and forest resources. Terracotta reader: A market approach to the environment, 12.

Ott, W. R. (2018). Environmental statistics and data analysis. Routledge.

Pacific GIS and Remote Sensing Council. (2021). Suva, Fiji. http://www.pgrsc.org/wp-content/uploads/2021/07/PGRSC-Booklet_2021.pdf

Pârvu, I.M., Cuibac Picu, I.C., Dragomir, P.D. and Pantan, R. (2021) Promoting Open Data services to decision-makers: Providing interactive data through Web Maps and Web Applications for Oradea city and Bihor County. IOP Conference Series: Earth and Environmental Science, 664(1), pp. 012073.

Pârvu, I.M., Cuibac Picu, I.C., Dragomir, P.D. and Pantan, R. (2021). Promoting Open Data Services to Decision-Makers: Providing Interactive Data Through Web Maps and Web Applications for Oradea City and Bihor County. Iop Conference Series: Earth and Environmental Science, 664(1), Pp. 012073.

Patterson, T.C., (2007). Google Earth as A (Not Just) Geography Education Tool. Null, 106(4), Pp. 145-152.

Perez, A.C., Grafton, B., Mohai, P., Hardin, R., Hintzen, K. and Orvis, S. (2015). Evolution of The Environmental Justice Movement: Activism, Formalization and Differentiation. Environmental Research Letters, 10(10), Pp. 105002.

Phua, M. and Minowa, M. (2005). A GIS-Based Multi-Criteria Decision-Making Approach to Forest Conservation Planning At A Landscape Scale: A Case Study in The Kinabalu Area, Sabah, Malaysia. Landscape and Urban Planning, 71(2), Pp. 207-222.

Price, M. H. (2019). Switching to ArcGIS Pro from ArcMap. PHOTOGRAMMETRIC ENGINEERING & REMOTE SENSING, 85(12), 861.

Prokopy, L.S., Floress, K., Arbuckle, J.G., Church, S.P., Eanes, F.R., Gao, Y., Gramig, B.M., Ranjan, P. and Singh, A.S. (2019). Adoption of Agricultural Conservation Practices in The United States: Evidence From 35 Years of Quantitative Literature. Journal of Soil and Water Conservation, 74(5), Pp. 520-534.

Published Online: 15 Jan 2020 https://doi.org/10.5465/annals.2017.0103

Questions and Answers About Giz.
Available: Https://Www.Giz.De/En/Press/9785.Html [Feb 3, 2022].

Questions and answers about GIZ.
Available: https://www.giz.de/en/press/9785.html [Accessed: Feb 3, 2022].

Rahman, M. M., Rahman, M. M., & Islam, K. S. (2010). The causes of deterioration of Sundarban mangrove forest ecosystem of Bangladesh: conservation and sustainable management issues. Aquaculture, Aquarium, Conservation & Legislation, 3(2), 77-90.

Rajabifard, A., & Williamson, I.P. (2002). Spatial Data Infrastructures: An Initiative to Facilitate Spatial Data Sharing.

Ranjan, P., Singh, A.S., Tomer, M.D., Lewandowski, A.M. and Prokopy, L.S. (2019). Lessons Learned from Using A Decision-Support Tool for Precision Placement of Conservation Practices in Six Agricultural Watersheds in The Us Midwest. Journal of Environmental Management, 239, Pp. 57-65.

Repetto, R., & Gillis, M. (Eds.). (1988). Public policies and the misuse of forest resources. Cambridge University Press.

Robey, Daniel and Taylor, Wallace T.F (2018) "Engaged Participant Observation: An Integrative Approach to Qualitative Field Research for Practitioner-Scholars," Engaged Management ReView: Vol. 2: Iss. 1, Article 1. Available at: https://doi.org/10.28953/2375-8643.1028

Robinson, S., (2020). Climate Change Adaptation in Sids: A Systematic Review of The Literature Pre and Post the Ipcc Fifth Assessment Report. Wiley Interdisciplinary Reviews: Climate Change, 11(4), Pp. E653.

Rondinini, C. and Chiozza, F. (2010). Quantitative Methods for Defining Percentage Area Targets for Habitat Types in Conservation Planning. Biological Conservation, 143(7), Pp. 1646-1653.

Rönnqvist, M., D'amours, S., Weintraub, A., Jofre, A., Gunn, E., Haight, R.G., Martell, D., Murray, A.T. and Romero, C. (2015). Operations Research Challenges in Forestry: 33 Open Problems. Annals of Operations Research, 232(1), Pp. 11-40.

Ruddell, S., Sampson, R., Smith, M., Giffen, R., Cathcart, J., Hagan, J., Sosland, D., Godbee, J., Heissenbuttel, J., Lovett, S., Helms, J., Price, W. and Simpson, R. (2007). The Role for Sustainably Managed Forests in Climate Change Mitigation. Journal of Forestry, 105(6), Pp. 314-319.

Sample, V. A. and Sedjo, R. A. (1996) Sustainability in forest management: An evolving concept, International Advances in Economic Research, 2(2), p. 165. doi: 10.1007/BF02295056.

Sayer, J.A., Vanclay, J.K. and Byron, N. (1997). Technologies for Sustainable Forest Management: Challenges for the 21st Century. The Commonwealth Forestry Review, 76(3), Pp. 162-170.

Schleyer, T.K.L. and Forrest, J.L. (2000). Methods for The Design and Administration of Web-Based Surveys. Journal of The American Medical Informatics Association, 7(4), Pp. 416-425.

Schmidheiny, S., (1992). Guest Article: The Business of Sustainable Development. Finance & Development, 29(004).

Scobie, M. (2019): Sustainable development and climate change adaptation: Goal interlinkages and the case of SIDS. in: Klöck, C. & Fink, M. (eds.): Dealing with

climate change on small islands: Towards effective and sustainable adaptation? (pp. 101–122). Göttingen: Göttingen University Press. https://doi.org/10.17875/gup2019-1213

Shah, M., & Asad, M. (2018). Effect of motivation on employee retention: Mediating role of perceived organizational support. European Online Journal of Natural and Social Sciences, 7(2), pp-511.

Sharifi, M. A., & Hussin, Y. A. (2004). Development of effective information systems supporting monitoring and certification process of production forest in Indonesia: concept and progress. in ISPRS 2004: proceedings of the XXth ISPRS congress: Geo-imagery bridging continents, 12-23 July 2004, Istanbul, Turkey. Comm. VII. pp. 347-351 (pp. 347-351). International Society for Photogrammetry and Remote Sensing (ISPRS). http://www.itc.nl/library/Papers_2004/peer_conf/sharifi_dev.pdf

Simao Da Graca Dias, E. (2007) The added value of contextual information in natural areas: Measuring impacts of mobile environmental information, PhD, Vrije Universiteit Amsterdam, Amsterdam. Available: https://research.vu.nl/en/publications/the-added-value-of-contextual-information-in-natural-areas-measur [Accessed: 19/02/2022]

Siry, J.P., Cubbage, F.W. and Ahmed, M.R. (2005). Sustainable Forest Management: Global Trends and Opportunities. Forest Policy and Economics, 7(4), Pp. 551-561.

Skov, H., Durinck, J., Leopold, M.F. and Tasker, M.L. (2007). A Quantitative Method for Evaluating the Importance of Marine Areas for Conservation of Birds. Biological Conservation, 136(3), Pp. 362-371.

Sousa, M., Almeida, M.F. and Calili, R. (2021) Multiple Criteria Decision Making for the Achievement of the UN Sustainable Development Goals: A Systematic Literature Review and a Research Agenda.

Sousa, M.,Almeida, M.F. and Calili, R.,.(2021). Multiple Criteria Decision Making for The Achievement of The Un Sustainable Development Goals: A Systematic Literature Review and A Research Agenda.

Souza, C.M., Roberts, D.A. and Cochrane, M.A. (2005). Combining Spectral and Spatial Information to Map Canopy Damage from Selective Logging and Forest Fires. Remote Sensing of Environment, 98(2), Pp. 329-343.

Stone, D.L., Deadrick, D.L., Lukaszewski, K.M. and Johnson, R. (2015). The Influence of Technology on The Future of Human Resource Management. Human Resource Management Review, 25(2), Pp. 216-231.

Sullivan, K., Thomas, S. and Rosano, M. (2018). Using Industrial Ecology and Strategic Management Concepts to Pursue the Sustainable Development Goals. Journal of Cleaner Production, 174, Pp. 237-246.

Takam Tiamgne, X., Kanungwe Kalaba, F., Raphael Nyirenda, V. and Phiri, D. (2022). Modelling Areas for Sustainable Forest Management in A Mining and Human

Dominated Landscape: A Geographical Information System (GIS)- Multi-Criteria Decision Analysis (Mcda) Approach. Null, , Pp. 1-15.

Tang, L. and Shao, G. (2015). Drone Remote Sensing for Forestry Research and Practices. Journal of Forestry Research, 26(4), Pp. 791-797.

Tarique, I. and Schuler, R.S. (2010). Global Talent Management: Literature Review, Integrative Framework, and Suggestions for Further Research. Journal of World Business, 45(2), Pp. 122-133.

Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a Qualitative Research Approach. Journal of graduate medical education, 7(4), 669–670. https://doi.org/10.4300/JGME-D-15-00414.1

Temiz, N. and Tecim, V. (2009). The Use of GIS and Multi-Criteria Decision-Making as A Decision Tool in Forestry. Null, 22(2), Pp. 105-123.

Thomas, A., Baptiste, A., Martyr-Koller, R., Pringle, P. and Rhiney, K. (2020). Climate Change and Small Island Developing States. Annual Review of Environment and Resources, 45(6), Pp. 1-6.27.

Tiu Wright, L., (1996). Exploring The in-Depth Interview as A Qualitative Research Technique With American and Japanese Firms. Marketing Intelligence & Planning, 14(6), Pp. 59-64.

Torres-Lezama, A., Ramírez-Angulo, H., Vilanova, E., & Barros, R. (2008). Forest resources in Venezuela: current status and prospects for sustainable management. Bois et Forêt des Tropiques, 295(1), 21-33.

Tourangeau, R., 2018. Confidentiality, Privacy, and Anonymity. in: D.L. Vannette and J.A. Krosnick, Eds, The Palgrave Handbook of Survey Research. Cham: Springer International Publishing, Pp. 501-507.

United Nations Climate Change. (2018, 0 0). 2018 Talanoa Dialogue Platform. 2018 Talanoa Dialogue Platform; unfccc.int. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/2018-talanoa-dialogue-platform#:~:text=%22Talanoa%20is%20a%20traditional%20word,decisions%20for%20the%20collective%20good.

United Nations, n.d. Sustainable Development - The 17 Goals. [Online] Available at: https://sdgs.un.org/goals [Accessed: March 3rd, 2022].

United Nations. (2015). Transforming our world: The 2030 agenda for sustainable development. New York: United Nations, Department of Economic and Social Affairs.

University of Melbourne. (2015, September 14). World has lost three percent of its forests since 1990: But losses have slowed significantly over the past decade. *ScienceDaily*. Retrieved August 9, 2022, from www.sciencedaily.com/releases/2015/09/150914102748.html

Upadhyay, D., (2021). Consideration of Future Consequences and Decision-Making Patterns as Determinants of Conflict Management Styles. IIMB Management Review, 33(1), Pp. 5-14.

Useng, N. (2017). Determinants of knowledge workers retention. วารสาร วิทย บริการ มหาวิทยาลัย สงขลา นครินทร์| Academic Services Journal, Prince of Songkla University, 28(3), 161-168.

Vacik, H. and Lexer, M.J. (2001). Application of A Spatial Decision Support System in Managing The Protection Forests of Vienna for Sustained Yield of Water Resources. Forest Ecology and Management, 143(1), Pp. 65-76.

Vakacequ N. (2015). ¼ Century GIS and RS in Fiji Forestry. Pacific GIS and Remote Sensing Conference, Suva, Fiji. Available: https://gisconference.gsd.spc.int/presentations_2015/Day2/session1/PacGIS_RS_2015_D2S1_Century_Fiji_Forestry.pdf Accessed: 10/03/2022

Van Der Horst, D., (2006). Spatial Cost–Benefit Thinking in Multi-Functional Forestry; Towards A Framework for Spatial Targeting of Policy Interventions. Ecological Economics, 59(1), Pp. 171-180.

Varma, V.K., Ferguson, I. and Wild, I. (2000) Decision support system for the sustainable forest management. Forest Ecology and Management, 128(1), pp. 49-55.

Varma, V.K., Ferguson, I. and Wild, I. (2000). Decision Support System for The Sustainable Forest Management. Forest Ecology and Management, 128(1), Pp. 49-55.

Vinten, G. (1994), "Participant Observation: A Model for Organizational Investigation?", Journal of Managerial Psychology, Vol. 9 No. 2, pp. 30-38. https://doi.org/10.1108/02683949410059299

Von Gadow, K., Pukkala, T. and Tomé, M., 2001. Sustainable Forest Management. Springer Netherlands.

Waas, T., Hugé, J.,Block, T.,Wright, T.,Benitez-Capistros, F. and Verbruggen, A.,.(2014). Sustainability Assessment and Indicators: Tools in A Decision-Making Strategy for Sustainable Development.

Wanniarachchi, H.E., Kumara Jayakody, J., Arachchilage Sisira and Jayawardana, A.K.L. (2022). An Organizational Perspective on Brain Drain: What Can Organizations Do to Stop It? Null, 33(8), Pp. 1489-1525.

Webb, J.A., Wealands, S.R., Lea, P., Nichols, S.J., De Little, S.C., Stewardson, M.J., Norris, R.H., Chan, F., Marinova, D. and Anderssen, R.S., 2011eco Evidence: Using the Scientific Literature to Inform Evidence-Based Decision Making in Environmental Management, Modsim2011 International Congress on Modelling and Simulation 2011, Pp. 2472-2478.

Weintraub, A., & Bare, B. B. (1996). New issues in forest land management from an operations research perspective. Interfaces, 26(5), 9-25.

Weischedel, B., Matear, S. and Deans, K.R. (2005). A Qualitative Approach to Investigating Online Strategic Decision Making. Qualitative Market Research: An International Journal, 8(1), Pp. 61-76.

Weiss, E.B., (1990). Our Rights and Obligations to Future Generations for The Environment. American Journal of International Law, 84(1), Pp. 198-207.

Wilkie, M.L., (2002). Climate Change, Forests and SIDS. The International Forestry Review, , Pp. 313-316.

World Health Organization (2015) Human health and climate change in Pacific Island countries.

Wright, K.B., (2017). Researching Internet-Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages, and Web Survey Services. Journal of Computer-Mediated Communication, 10(3), Pp. Jcmc1034.

Wu, B., Meng, X., Ye, Q., Sharma, R.P., Duan, G., Lei, Y. and Fu, L. (2020) Method of Estimating Degraded Forest Area: Cases from Dominant Tree Species from Guangdong and Tibet in China.

Wu, B.,Meng, X.,Ye, Q.,Sharma, R.P.,Duan, G.,Lei, Y. and Fu, L.,.(2020). Method of Estimating Degraded Forest Area: Cases from Dominant Tree Species from Guangdong and Tibet in China.

Wu, M., Zhao, K. and Fils-Aime, F. (2022). Response Rates of Online Surveys in Published Research: A Meta-Analysis. Computers in Human Behaviour Reports, 7, Pp. 100206.

Yamada, Y., (2018). Can A Regional-Level Forest Management Policy Achieve Sustainable Forest Management? Forest Policy and Economics, 90, Pp. 82-89.

Yamaura, Y., Yamada, Y., Matsuura, T., Tamai, K., Taki, H., Sato, T., Hashimoto, S., Murakami, W., Toda, K., Saito, H., Nanko, K., Ito, E., Takayama, N., Tsuzuki, N., Takahashi, M., Yamaki, K. and Sano, M. (2021). Modelling Impacts of Broad-Scale Plantation Forestry on Ecosystem Services in The Past 60 Years and for The Future. Ecosystem Services, 49, Pp. 101271.

Yilmaz, K. (2013) Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences. European Journal of Education, 48(2), pp. 311-325.

Yilmaz, K., (2013). Comparison of Quantitative and Qualitative Research Traditions: Epistemological, Theoretical, and Methodological Differences. European Journal of Education, 48(2), Pp. 311-325.

Young, J.C., Marzano, M., Quine, C.P. and Ambrose-Oji, B. (2018) Working with decision-makers for resilient forests: A case study from the UK. Forest Ecology and Management, 417, pp. 291-300.

Young, J.C., Marzano, M., Quine, C.P. and Ambrose-Oji, B. (2018). Working With Decision-Makers for Resilient Forests: A Case Study from the UK. Forest Ecology and Management, 417, Pp. 291-300.

Yu, L. and Gong, P. (2012). Google Earth as A Virtual Globe Tool for Earth Science Applications at The Global Scale: Progress and Perspectives. Null, 33(12), Pp. 3966-3986.

Zerger, A., (2002). Examining GIS Decision Utility for Natural Hazard Risk Modelling. Environmental Modelling & Software, 17(3), Pp. 287-294.

Zhao, Q.,Yu, L.,Li, X.,Peng, D.,Zhang, Y. and Gong, P.,.(2021). Progress and Trends in The Application of Google Earth and Google Earth Engine.

APPENDIX

Interviewee Details

ID	Years in Ministry	Comments	What do you think is the value of location-based information in a forester's daily field life.	Do you think Decentralizing FRAC to have a GIS Officer/Data Officer in each division will be a good idea.	What is your opinion of the current data flow within the Ministry of location-based information?	Do you think NFMS will solve the problem?
Anon1	1	Highly educated, qualified and experienced professional.	Can't do sustainable forestry without it	Best Idea	Bleak -NFMS can possibly solve the problem	Maybe
Anon2	28	Spent most time in research division but has been in executive leadership in recent years.	Needs it daily	Definitely	Need restructure	Will have to wait and see
Anon3	32	Spent most time in operations division but has been in executive leadership a lot of years as well.	Is a good decision-making support tool	Definitely	NFMS will solve problems	Yes
Anon4	23	Spent most time in HQ on executive suport but also has extensive research and operations division experiences.	Is needed for making good judgements	Definitely	Data flow is not systemized	It should

Anon5	13	Spent most time in research division. Recently joined senior leadership in operations division.	Very important	Best Idea	-	-
Anon6	10	Spent most time in operations division. Recently joined leadership in research division.	Extremely necessary for good forestry	Definitely	Data flow needs to be systemized	-
Anon7	23	Spent most time in research division but has experience of operations divisions as well.	Needed for making sound decisions	Definitely	Data flow needs to be systemized	-
Anon8	8	Spent most time in research division but has experience of operations divisions as well.	Plays an important role	Definitely	Data flow needs to be systemized	-
Anon9	13	Spent most time in research division. Recently joined senior leadership in operations division.	Needed in real time	Best Idea	Data flow needs to be systemized	-
Anon10	17	Always been in operations division.	Important	Definitely	Data flow needs to be systemized	-
Anon11	11	Always been in operations division.	Needed	Definitely	Data flow needs to be systemized	-
Anon12	23	Always been in operations division.	Plays a crucial role	Definitely	Data flow needs to be systemized	-

Anon13	15	Spent most time in operations division having joined research division recently.	Not a good forester without it	Definitely	Data flow needs to be systemized	-
Anon14	32	Spent most time in operations division but has been in executive leadership a lot of years as well.	An essential support tool for decision making	Definitely	Data flow needs to be systemized	It should.
Anon15	32	Spent most time in research division but has been in executive leadership a lot of years as well.	Plays a very important role in their daily work	Best Idea	Data flow needs to be systemized	-