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Developing maritime search and rescue in Tuvalu

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DEVELOPING MARITIME SEARCH AND RESCUE IN TUVALU

By

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Tuvalu

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DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

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ABSTRACT

Title of Dissertation: Developing maritime search and rescue in Tuvalu
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Search and rescue serves the purpose of saving lives in imminent danger at sea. Tuvalu is a maritime nation that depends mainly on shipping services for economic development and sustainability of its population. According to the International Convention for the safety of life at sea (SOLAS) and the United Nations Law of the sea convention (UNCLOS) signatory states must provide maritime search and rescue services. SAR has become a higher priority with the growing shipping trade, fisheries industry and demand for maritime transport. Tuvalu has not ratified the International Maritime Organization (IMO) Maritime Search and Rescue Convention (SAR) 1979 and this study will be based on developing the requirements to facilitate maritime SAR.

The methodology examines Tuvalu national SAR organization limitations which is supplemented by a questionnaire and to adopt basic principles and good practices from SAR services in developed countries. The main objective of the questionnaire sent to targeted respondents in the Tuvalu maritime administration was to collect information and to analyze weak areas for proposals to improve SAR in Tuvalu. Firstly, the background of the maritime situation in Tuvalu with focus on Fiji SRR will be discussed, global and regional issues of maritime SAR incidents with the regulatory framework of the UNCLOS, IMO SOLAS convention, GMDSS and maritime SAR convention will be briefly introduced. The final Chapter, the author will discuss the proposal and recommendations for SAR national policy development, SAR organizational structure, SAR personnel training, SAR resources and systems management.

KEYWORDS: Search and Rescue (SAR), SOLAS, Tuvalu, IMO, UNCLOS, GMDSS, SRR.

TABLE OF CONTENTS

CHAPTER THREE: TUVALU OVERVIEW AND PACIFIC SAR

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ABM	Australian Bureau of Meteorology
AIS	Automatic Identification System
AIS-SART	Automatic Identification System Search & Rescue Transponder
AMSA	Australian Maritime Safety Authority
ARCC	Aeronautical Rescue Coordination Centre
AUSCOAST	Australian Coast
CES	Coast Earth Station
COSPAS	Search and Rescue Satellite-Aided Tracking
CPSC	Central Pacific Shipping Commission
DMPS	Director of Marine and Port Services
DSC	Digital Selective Calling
EGC	Enhanced Group Call
EEZ	Exclusive Economic Zone
ELT	Emergency Locator Transmitters
EMSA	European Maritime Safety Administration
ENSO	El Nino Southern Oscillation
EPIRB	Emergency position indicating radio beacon
FAO	Food and Agricultural Organization
FFV	Foreign Fishing Vessel
FV	Fishing vessel
GDP	Gross Domestic Product
GEOLUT	Geostationary satellite system local user terminal
GEOSAR	Geostationary Earth Orbit SAR Satellite
GMDSS	Global Maritime Distress and Safety System
GOT	Government of Tuvalu
GT	Gross Tonnage
HF	High Frequency
IAMSAR	International Aeronautical and Maritime Search and Rescue

ICAO	International Civil Aviation Organization
IHO	International Hydrographic Organization
ILO	International Labor Organization
ILS	International Lifesaving Federation
IMO	International Maritime Organization
IMRF	International Maritime Rescue Federation
IMSO	International Mobile Satellite Organization
IPO	Interdecadal Pacific Oscillation
ITU	International Telecommunication Union
IUU	Illegal, Unreported, Unregulated
JRCC	Joint Rescue Coordinated Center
KHz	Kilohertz
LDC	Least Developed Country
LES	Land Earth Stations
LEOLUT	Low earth orbit land user terminal
LEOSAR	Low-altitude Earth Orbit SAR satellites
LINZ	Land Information New Zealand
LRIT	Long Range Identification and Tracking
LSA	Life Saving Appliance
LUT	Local User Terminal
MARPOL	International convention on the prevention of marine pollution
MASTREP	Modernised Australia Ship Tracking and Reporting System
MCC	Mission Control Center
MCT	Ministry of Transport and Communication
MEDIVAC	Medical Evacuations
MEOSAR	Medium-altitude Earth Orbit Satellite Search and Rescue System
METAREA	Meteorological Areas
MF	Medium Frequency
MHz	Megahertz
MMSI	Maritime Mobile Satellite Identity

MRCC	Maritime Rescue Coordination Centre
MRSC	Maritime Rescue-Sub Center
MSC	Maritime Safety Committee
MSI	Maritime Safety Information
NATSAR	National search and rescue council
NAVAREA	Navigational Areas
NAVTEX	NAVigational TEleX
NBDP	Narrow Band Direct Printing
NCC	National Coordination Centre
PACSAR	Pacific Search and Rescue
PLB	Personal Locator Beacon
RCC	Rescue Coordination Centre
RCCNZ	Rescue Coordination Center New Zealand
RPA	Remotely-piloted aircraft systems
REC	Research Ethics Committee
RSC	Rescue sub-center
RT	Radiotelephony
RV	Research vessel
SAR	Search and Rescue
SARSAT	COsmicheskaya Sisteyama Poiska Avariynich Sudov
SES	Inmarsat Ship Earth Stations
SIDS	Small Islands Developing States
SOLAS	International convention on the Safety of life at sea
SPC	South Pacific Commission
SPCZ	South Pacific Convergence Zone
SPTO	South Pacific Tourism Organization
SRR	Search and Rescue Region
SRS	Ship Reporting System
SSB	Single Side Band
TFD	Tuvalu Fisheries Department
TPF	Tuvalu Police Force

TSR	Tuvalu Ship Registry
UAVs	Unmanned Aerial Vehicles
UHF	Ultra High Frequency
UN	United Nations
UNCLOS	International Convention on the Law of the Sea
UNCSIDS	United Nations Conference on Small Islands Developing States
UNCTAD	United Nations Conference on Trade and Development
UNHCR	United Nations High Commissioner for Refugees
USDSBO	United States Department of State Bureau of Oceans
VHF	Very High Frequency
VMS	Vessel Monitoring Services
WHO	World Health Organization
WMO	World Meteorological Organization
WMU	World Maritime University

CHAPTER ONE: INTRODUCTION AND RESEARCH METHODOLOGIES

1.1 Introduction

The Pacific Ocean covers one-third of the earth surface and is bounded by the isolated Small Islands Developing States (SIDS). As the maritime world transition to modern shipbuilding to increase passenger and cargo capacity, the risks involved in accidents and disasters also increases causing frequent occurrence of shipwrecks. The International Convention on safety of life at sea (SOLAS) have been adopted by the IMO in 1960 when it was considered the most important convention as a response to the Titanic disaster that causes the loss of more than 1600 passengers and crew. The notion of maritime safety came into reality as this had not been the case before of prioritizing human life at sea more important than property.

Tuvalu is centrally located in the Pacific Ocean within the boundaries of important shipping routes between the latitude of 5 to 10 degrees south and longitude of 176 to 180 degrees east (FAO, 2012) and the increase of commercial fisheries and trades on the inshore and offshore waters have intensified risks to maritime safety. Search and rescue (SAR) is the assistance and provision of aid to people who are in distress at sea by the use of aircraft, surface craft, submarines and specialized rescue teams (US-Legal, 2019). SAR is important to Tuvalu and the Pacific where vast distances and limited resources have intensified issues in the rescue coordination between states.

1.2 Problem Statement

The maritime sector is a key link in the world transport chain providing more than 80 per cent of global trade by volume and the backbone of the global economy (UNCTAD, 2018). Although ship safety systems been developed over the years, maritime accidents and risks involving deaths at sea are still becoming apparent. UNHCR (2019) reported that in 2018 an estimated 2,275 refugees lost their lives at an alarming rate with 6 persons died each day attempting to cross Mediterranean sea.

European Maritime Safety Administration (2013) reported that globally 802 ships needed a SAR operation and 40 per cent of these were fishing vessels, 60 per cent of the SAR operations related to a ship casualty and 40 per cent to occupational accidents. WHO (2014) reports "that every hour in a day more than 40 people lose their lives to drowning a serious and neglected public health threat claiming the lives of 372,000 people a year worldwide. More than 90 per cent of these deaths occur in low and middle-income countries".

According to the International Life Saving Federation (2019) states that "there are 1.2 million people around the world died by drowning every year, that is more than two persons per minute. From that more than 50 per cent is children". This has increased countries response to IMO International Convention on Maritime Search and Rescue (1979), entered into force on the 22nd June 1985 so far have been ratified by 113 states with 80.4 per cent of world tonnage (IMO, 2019).

FAO (2003) report on sea safety in Tuvalu "estimated that in the whole country there were around 200 motorized boats and 500 non-motorized canoes are privately-owned and not more than six meters length overall. The search and rescue operations in the country are inefficient and ineffective, causes loss of life on fishing vessels due to bad weather, loss of power and alcohol influence". World Bank (2015) reported that local SAR assets and resources are very limited, and there is no dedicated SAR boat. Tuvalu encounters challenges in responding to calls for search of missing vessels, often involving small boats used by fishermen that lack emergency equipment.

Within the ocean of the Pacific nations the Central Pacific Shipping Commission (CPSC) increased frequency and regularity of ship visits in 2016 for its member countries including Tuvalu. There are 1,417 vessels from 2014 to 2018 engaged in fishing operations within the Tuvalu EEZ, 63 per cent are purse seiners and 37 per cent including long liner, Bunker and Fish Carriers (GOT, 2018). The booming tourism industry in the pacific islands and developed artisanal and oceanic fisheries, commercial trades with neighboring countries accordingly is crucial to Tuvalu economic development.

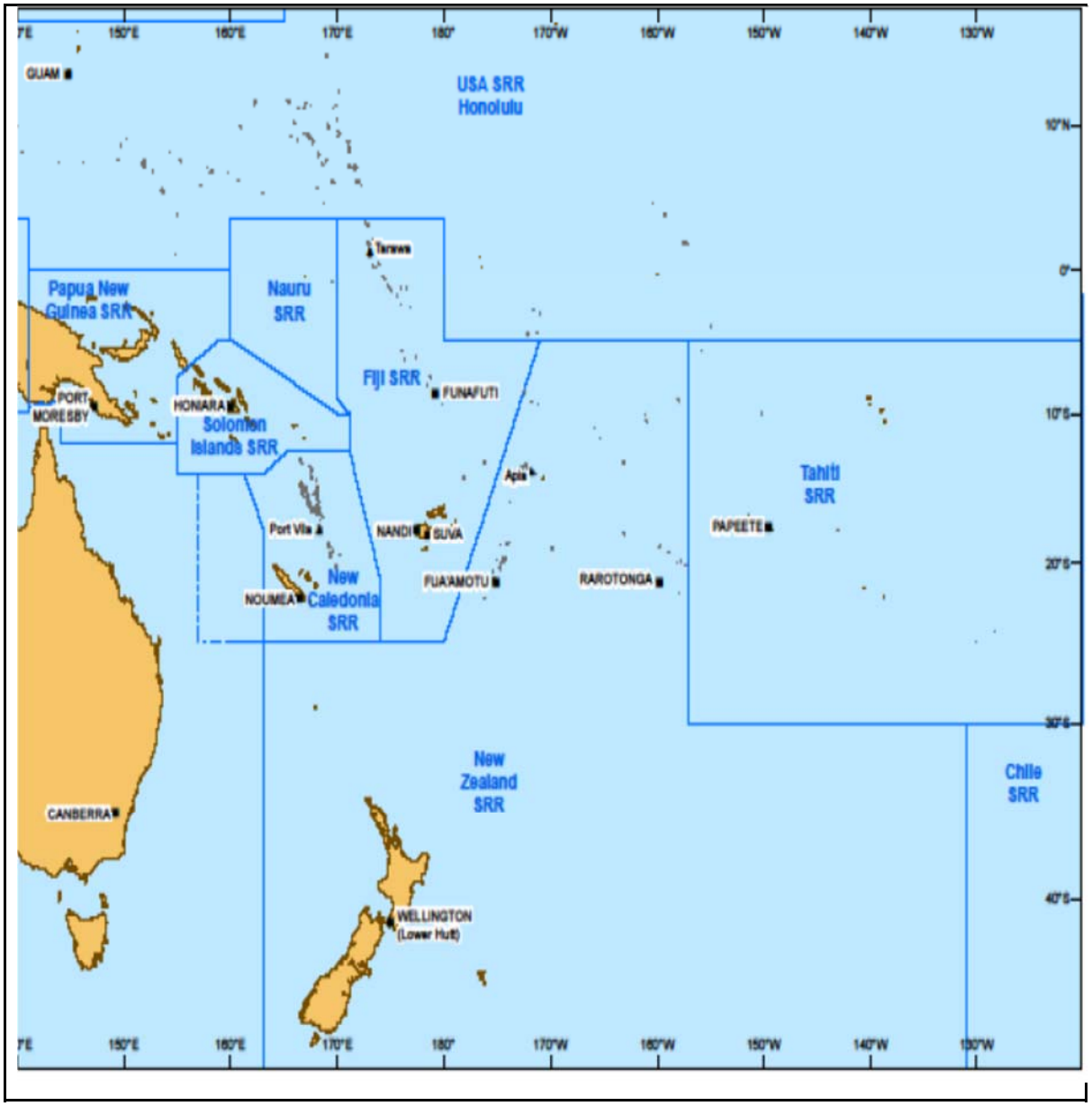
The fishermen and locals travelling on outboard motorboats are common incidents as a result of engine failure and being caught in a bad weather causes boats to drift for days and weeks. The complexity of monitoring these boats at night and across maritime boundaries causes conflicts between neighboring pacific island states. In terms of limited SAR resources and the sheer expanse of ocean space each country covers further exacerbates the timely response to any SAR incident. Moreover, predominant adverse weather conditions due to increasing climate change impacts are a threat to vessels operating within Tuvalu's jurisdictional boundaries and extremely vulnerable if their boat founder with limited resources for survival.

Tuvalu illustrated in Figure 1 is bound by Fiji search and rescue region (SRR) jurisdiction. Fiji SAR region is obliged to coordinate SAR operations, take command with centralization of all distress alerts. According to IMO (2019) Fiji have not fully ratified the International convention on maritime search and rescue (1979) and South Pacific Commission (2017) reported issues in the Fiji SAR includes:

1. Fiji SRR does not have a dedicated SAR manual and plan;
2. Issues in demarcation of roles in joint operations;
3. Issues on deficiencies in communication systems and SAR operators;
4. incapability of search platforms.

Based on the status of Fiji SRR limitations and non-conformity to SAR standards and requirements, it is apparent that Fiji SAR is not capable of performing its obligations to respond to any emergency for countries that are within its search and rescue regions in particular Tuvalu. This further causes a potential threat on maritime safety in Tuvalu relying on Fiji SAR for assistance, thus will limit the facilitation of SAR response to other neighboring countries and territories under the Pacific SAR regions. The CPSC also strengthened shipping and international trade for member countries which search and rescue can only be facilitated by the adoption and implementation of the SAR convention.

Figure 1: Map showing Tuvalu and Fiji SRR in the Pacific Ocean



Source: ICAO, 2014.

1.3 SAR Incidents

Marine SAR incidents in Tuvalu were related to:

1. Commercial fishing vessels;
2. Cargo and passenger vessels;
3. Recreational yachts within Tuvalu EEZ;
4. Privately owned and fishing boats less than 5 meters in length overall used for passenger transfers, commercial and subsistence fishing activities.

The main causes of death at sea in the Pacific Ocean is starving, drowning and hypothermia mainly as a result of persons falling overboard intentionally or unnoticed, sinking and capsizing of boats or vessels and types of marine incidents are based on certain factors such as:

1. Incompetent boat operators;
2. malfunction of emergency VHF/MF/HF radio communication systems;
3. material and hull failure due to overloading;
4. Unavailability of communication equipment such as VHF, MF, HF radios or satellite phones to contact coast radio stations or RCC for assistance in emergency;
5. Poor weather forecasting;
6. Poor stability condition;
7. limited or no lifesaving equipment;
8. Low on fuel; and
9. technical failure of outboard engines.

Table 1: Summary of SAR cases from 2015 to 2017

Year	Total no. of cases	No. of person involved	No. of cases found	No of lives lost
2015	13	21	13	0
2016	5	18	5	0
2017	7	18	7	0

Source: SPC, (2017).

1.4 National SAR governance

Tuvalu maritime SAR governance is limited to its territorial sea (ICAO, 2014, p.15), SAR framework and coordination are monitored by the government marine department and Tuvalu Police Force (South Pacific Commission, 2017). The IMO SOLAS convention have been adopted into the Tuvalu merchant shipping act 2008 CAP.48.28 Section 47.1 national legislation states that:

> "Subject to this Act, the Safety Convention, the Load Line Convention, the Tonnage Measurement Convention, the Collisions Convention and the Limitation of Liability Convention shall have the force of law in Tuvalu".

As a signatory to the IMO SOLAS convention Tuvalu has an obligation as a coastal state:

- To adopt and ratify the maritime search and rescue 1979 convention;

- Establish effective and efficient maritime SAR services to support the maritime communities and transport sector to promote the safety of life at sea.

1.5 Primary objective of the research

The objective of this research is primarily to develop maritime SAR in Tuvalu by the purpose of adopting and ratifying the SAR convention. Firstly, the study of the regulatory framework of maritime SAR and the current situation of the maritime background in Tuvalu will be introduced to discuss obligations of coastal states and flag states under international law to render assistance and provide SAR services.

With reference to Tuvalu within Fiji SRR jurisdiction for SAR response the research will further strengthened Tuvalu SAR capability to be independently developed to provide SAR services within its EEZ and to be a signatory to the SAR convention whilst maintaining its position in the Fiji SRR.

Moreover, Tuvalu will be able to develop its regional SAR system to deal with local SAR responses while also strengthening Fiji SAR capability and performance by sharing resources and inclusiveness for collaboration in response for massive SAR incidents.

To further develop the research, a detailed study of Pacific SAR in Fiji and Australia critical elements and systems to analyze how SAR services are provided in these countries by referring on their basic principles and good practices to develop strategies for implementation of SAR in Tuvalu.

In conclusion, the author will make proposals and review of discussions based on questionnaires and online data obtained from the research to identify gaps and draw conclusions for an appropriate national SAR organizational structure, develop national SAR plan, national SAR committee, SAR personnel capacity building and SAR systems management.

Recommendations to establish a MRSC to cover rescue coordination to Sea area 3 and the establishment of SAR support resources including UAVs and Helicopter services to enhance the efficiency of SAR operations within Tuvalu EEZ. A summary of the following research questions will identify the objectives of the dissertation:

1) What is the current status of maritime search and rescue in Tuvalu?

2) What are the requirements to implement the IMO SAR convention in Tuvalu?

1.6 Research Methodology

The approach for this dissertation is based on both Qualitative and Quantitative research methodologies. The qualitative analysis focused on progression, development of communication functions and systems in the GMDSS, concept of COSPAS-SARSAT and INMARSAT satellite communication system. Systems for assistance and coordination of SAR responses including EPIRB, SART, DSC, AIS, LRIT and maritime safety information (MSI) system.

Shore-based communication network and operation of RCC, MRCC, MRSC, MCC and RSC. The GMDSS sea areas coverage and the regulatory framework relevant to SAR convention by IMO were reviewed.

For the purpose of conducting a survey on the status of maritime search and rescue in Tuvalu a structured text questionnaire method was used, the author had designed a questionnaire on the national self-assessment on SAR according to the IAMSAR manual requirements with slight modification to cover the four aspects of SAR services: national SAR policy, SAR training, SAR resources and SAR system management.

The main objective of the questionnaire was to collect information on the current status of SAR provision and practices in Tuvalu and recommendations by government officials within the national SAR organization in order to analyze to determine the best approach in improving SAR in Tuvalu.

To improve the credibility of the questionnaire a thorough consultation with WMU students and faculty staffs for their comments and feedback which were quite helpful and valuable. Based on the specific questionnaire submitted and approved by WMU REC provided in Appendix 1, the research was conducted by sending out to several pre-determined individuals using English as a communication medium within the government maritime administration and other relevant organizations in Tuvalu.

In addition, various kinds of literature relevant to the research were obtained from secondary data (online sources) and follow up telephone interview in regards to SAR in Tuvalu and reviewed to gather more information. IMO and ICAO documents obtained online were used to further research the latest SAR requirements and amendments.

Various IMO publications relevant to the study were used to discuss the legal framework and to identify technical requirements as references to this dissertation. The data obtained from responses received and online research were analyzed to discuss further make recommendations and conclusion to achieve the research objective.

1.7 Scope of thesis

The entire thesis will be structured to cover the following Chapters:

Chapter 1: Introduction and research methodologies

A brief overview of the background of Tuvalu and issues in maritime SAR both globally and regionally to identify the primary objectives, research methods and limitations of the dissertation.

Chapter 2: Regulatory framework of maritime search and rescue

This Chapter will discuss the regulatory framework and relevant conventions formed by the United Nations (UN) and International Maritime Organization (IMO), ICAO and IMO specific requirements to establish IAMSAR manual, GMDSS and Ship Reporting Systems to develop maritime search and rescue.

Chapter 3: Tuvalu overview and Pacific SAR

The background information and brief overview of the maritime transport sector in Tuvalu will be examined including relevant infrastructures to the research. A summary of Fiji SRR capabilities and their SAR system, Pacific search and rescue (PACSAR) organization including maritime search and rescue in Australia will be discussed.

Chapter 4: Conclusions and Recommendations for Tuvalu

The proposal will focus on developing SAR in Tuvalu by implementing policy framework for SAR organizational structure and plan, SAR personnel training, SAR resources and SAR systems management. Recommendations to establish MRSC to coordinate SAR operations, SAR decision support system based on UAVs and Helicopter services to achieve maximum speed, efficiency and effectiveness in SAR response.

CHAPTER TWO: REGULATORY FRAMEWORK OF MARITIME SAR

2.1 Introduction

The duty imposed on coastal states and masters to rescue persons in distress at sea is a fundamental rule of international law. This traditional moral obligation is recognized by mariners as a normal practice which forms the regulatory framework of SAR as a legally binding agreement to assist those in imminent danger at sea.

2.2 Review of the International Regulatory Framework on SAR

The regulatory framework regarding SAR specified by the UN and IMO instruments mainly involves two areas: coastal states and flag states. Coastal states are obligated to provide SAR services as a duty by a government or contracting governments while flag states responsibility usually is transferred to the master of the vessel whose ship is operating under that flag state administration to exercise duties and legal obligations as required by international law to proceed to distressed targets, wherever they may be and no matter the nationality or status, to provide necessary support.

2.3 United Nations Convention on the Law of the Sea (UNCLOS, 1982)

The United Nations Convention on the Law of the Sea (UNCLOS) was officially formulated at the third United Nations Conference on the Law of the sea, which took place between 1973 to 1982 and came into force in 1994. UNCLOS sets out an international legal framework governing shipping, codifies the rules underlying the nationality of ships and a body of public international law governing the rights and duties among states. The legal regime of UNCLOS in Article 98 Duties to render assistance requires coastal states and flag states that the:

> Master of a ship flying its flag, in so far as he or she can do so without serious danger to the ship, the crew or the passengers; to render assistance to any person found at sea in danger of being lost; to proceed with all possible speed to the rescue of persons in distress, if informed of their need of assistance, in so far as such action

> may reasonably be expected of him; after a collision, to render assistance to the other ship, its crew and its passengers and, where possible, to inform the other ship of the name of his own ship, its port of registry and the nearest port at which it will call; Shall promote the establishment, operation and maintenance of an adequate and effective search and rescue service regarding safety on and over the sea and, where circumstances so require, by way of mutual regional arrangements cooperate with neighboring States for this purpose.

2.4 International Convention for the Safety of Life at Sea

Obligations to protect humanity at sea under international law applies to coastal states and flag states to execute mandatory requirements. Tuvalu a signatory of the International Convention for the Safety of life at Sea (SOLAS) 1974 is obliged to enforce regulations relevant to the provision of maritime search and rescue. SOLAS Convention 1974 the most important of all treaties dealing with maritime safety as amended which currently has 156 contracting states, whose tonnage comprises of 98.79% of the world's total tonnage (IMO, 2019). Chapter V Regulation 7 of the SOLAS convention states the obligation by governments for search and rescue:

> Every coastal state shall promote the establishment, operation and maintenance of an adequate and effective search and rescue service regarding safety on and over the water and, where circumstances so require, by way of mutual regional arrangements, cooperate with neigbouring states for this purpose.

The effective collaboration in SAR operations required SAR plans to be implemented and carried onboard to provide proper procedures for the conduct of SAR operations particularly in Tuvalu which depends mainly on shipping for inter-island transportation to cooperate with other regional and international ships within the EEZ. According to Chapter V Regulation 7 paragraph 3 states:

> Passenger ships to which chapter 1 applies shall have on board a plan for co-operation with appropriate search and rescue services in the event of an emergency. The plan shall be developed in cooperation between the ship, the company, as defined in regulation IX/1, and the search and rescue services. The plan shall include provisions for periodic exercises to be undertaken to test its effectiveness. The plan shall be developed based on the guidelines developed by the Organization.

Most importantly Regulation 33 of SOLAS Chapter V states obligations and procedures for distress situations requires:

> The master of the ship at sea which is in a position to be able to provide assistance, on receiving information from any source that person are in distress at sea, is bound to proceed with all speed to their assistance, if possible informing them or the search and rescue service that the ship is doing so. This obligation to provide assistance applies regardless of the nationality or status of such persons or the circumstances in which they are found. If the ship receiving the distress alert is unable or, in the special circumstances of the case, considers it unreasonable or unnecessary to proceed to their assistance, the master must enter in the logbook the reason for failing to proceed to the assistance of the persons in distress, taking into account the recommendation of the organization to inform the appropriate search and rescue service accordingly.

(Source: SOLAS Manual, 2014)

2.5 International Convention on Maritime Search and Rescue (1979)

The duty to save persons and vessels in life-threatening situation at sea is legally binding for Masters concerned and it is a customary practice for seafarers to protect humanity. After several improvements for the SOLAS convention when IMO was established in 1958, IMO's first task was to adopt a new version of the SOLAS convention emphasizing on improving and provide a framework for search and rescue at sea. Obligations by flag states to provide SAR assistance of distressed persons at sea was adopted at an agenda in 1960 at the IMO conference in Hamburg.

The International Convention on Maritime Search and Rescue was completed in 1979, entered into force in 1985 dividing the world into 13 SAR areas with 105 states-parties (IMO, 2019) and aimed at developing an international SAR plan, so that, no matter where an accident occurs, the rescue operations at sea will be coordinated by a SAR organization and, when necessary, by co-operation between neighboring SAR organizations.

It was considered that there were some deficiencies in the SAR convention after adoption in 1979 which by the end of 1997 only 56 countries have ratified. Most of the world's coastal states had not accepted obligations of the convention as they do not have the capabilities to become parties to the SAR convention, because the convention imposes considerable obligations to set up shore installations.

On the 14th May 1998 amendments for the adoption of Resolution MSC.70(69) of the International convention on maritime search and rescue for technical provisions in the Annexes is to ensure that SAR operations are conducted with maximum speed, efficiency and effectiveness. The two old versions of IMO SAR manuals MERSAR and COMSAR have been superseded by the joint ICAO and IMO IAMSAR manuals to further harmonize the conduct of SAR operations by aircrafts and vessels.

The main objective of this study for Tuvalu to adopt the maritime SAR convention is to strengthen SAR capabilities and an obligation to establish a national Search and Rescue organization to give necessary support to vessels and persons in distress within its boundaries.

Initially, the SAR convention cannot be implemented without a Global SAR plan. For undeveloped countries it is important to establish a provisional SAR plan first to facilitate the completion of a global SAR plan which can be assisted through IMO.

Provisional SAR plans to be developed requires cooperation among states and use of all available resources then making it to be global before the adoption of the SAR convention. The transition from provisional to global SAR plan shall be agreed by neighboring states then submitted to IMO Secretary General for approval with a SAR agreement.

2.6 The International Aeronautical and Maritime Search and Rescue Manual (IAMSAR)

The prime purpose of the IAMSAR manual is to assist governments in the implementation of the requirements of the International SAR convention and the International Safety of Life at Sea convention (SOLAS) Chapter V Regulation 21.2 (IMO, 2014). The two conventions form a legal agreement between IMO and ICAO by way of mutual arrangements which requires governments to promote the establishment and maintenance of an adequate and effective search and rescue service and for vessels to carry an up-to-date International Aeronautical and Maritime Search and Rescue (IAMSAR) manual.

IAMSAR manual (2016) “mission coordination defined that search and rescue is the performance of distress monitoring, communication, coordination and search and rescue functions, including provision of medical advice, initial medical assistance, or medical evacuation, through the use of public and private resources, including cooperating aircraft, vessels and other craft and installations”.

Both IMO and ICAO developed the three-volume IAMSAR manual provides guidelines for a common aviation and maritime approach to organizing and providing search and rescue (SAR) services. The IAMSAR manual is divided into three volumes:

The organization and management volume of SAR operations, it requires government to establish and improve national and regional SAR systems adopt the global SAR concept, legal basis for services, communication and cooperation with neighboring countries to provide effective and economical SAR services.

The mission co-ordination volume deals with three levels associated with SAR coordinators, SAR mission coordinators and on-scene coordinators. Procedures and guidelines are provided to assist personnel who plan and co- ordinate SAR operations and exercises.

The mobile facilities volume deals with SAR coordination between vessels and aircrafts to assist others in distress at sea by ship master as obligations under international law, is intended to be carried aboard rescue units, aircraft and vessels to help with performance of a search, rescue or on-scene coordinator function, and with aspects of SAR that pertain to their own emergencies.

(Source: SAR Manual, 2000)

2.7 Introduction of the GMDSS

This Chapter will discuss the general concept of GMDSS as required by both SOLAS and SAR convention, to meet requirements and facilitate worldwide satellite communication for distress alerts and safety of life at sea. The acronym GMDSS stands for Global Maritime Distress and Safety System established in 1959, the IMO in close cooperation with the ITU, WMO, IHO, IMSO and with the COSPAS-SARSAT partners developed maritime distress and safety radio-communications (GMDSS Manual, 2017). What can SAR convention do is to facilitate SAR plans around the world's oceans but without radio communications SAR operations cannot be established. That is where the GMDSS comes in as these two elements are critical in performing SAR operations to execute plans effectively and efficiently.

The GMDSS is essentially a worldwide network of automated emergency communications for ships at sea, the basic concept of GMDSS illustrated in Figure 2 below.

2.7.1 Role of GMDSS in SAR operations

According to Parker & Mundy (2016) Tuvalu has not, and unlikely to ever implement GMDSS, the current status of which is summarized at Table 2 below. There are 7 ships that were missing/overdue in the 11 years from 2002 to 2013 (Lang, 2014) without a trace in the worldwide shipping trade and “over 32,000 fishermen die every year of more than 50% of the world's population lives within 60km of the coastline” (FAO, 2019).

The IHO conducted a survey in 2016 on Tuvalu maritime safety systems and shows insufficiency in the promulgation of MSI and relevant radio communications requirements in regards to GMDSS system.

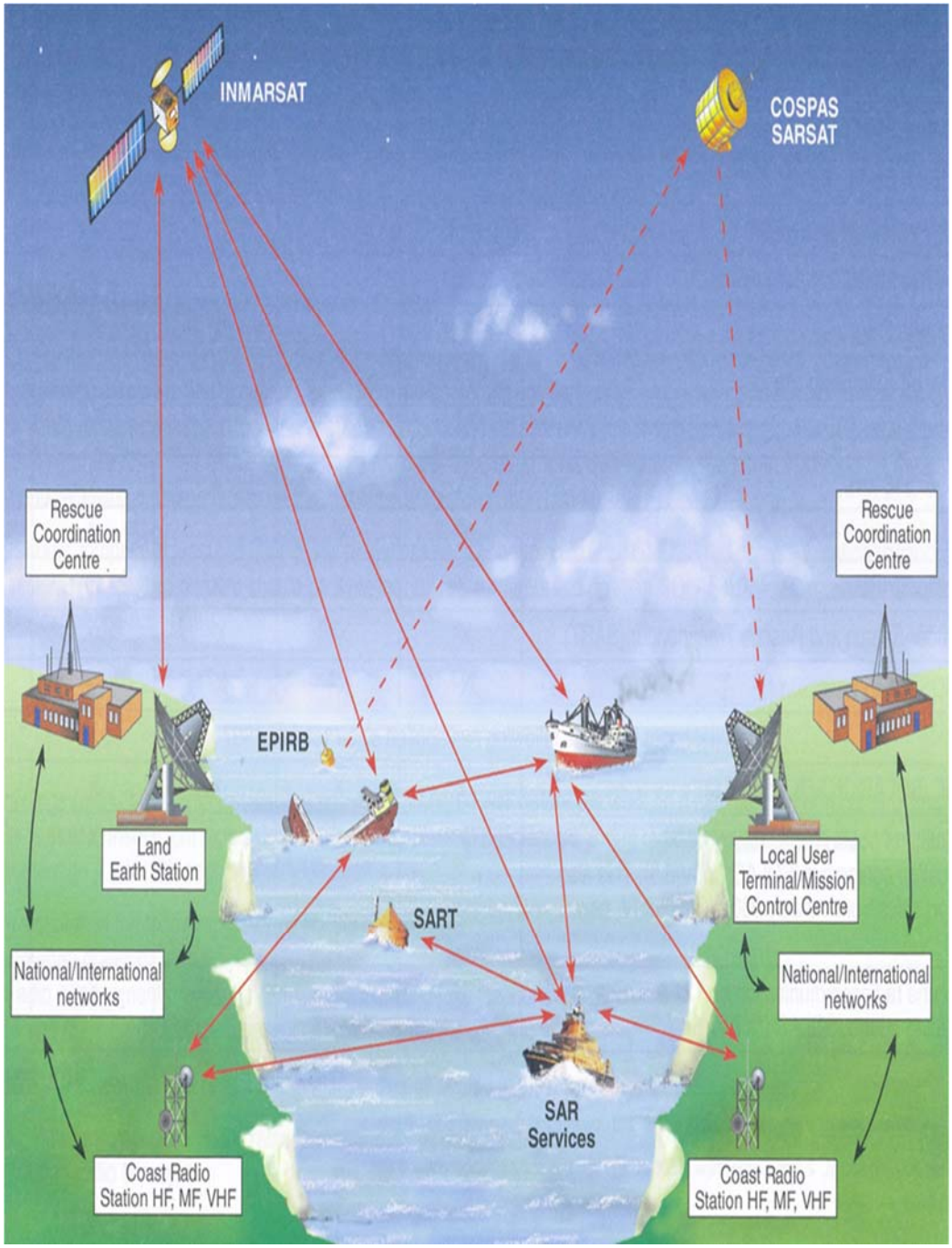
The role of GMDSS mainly in SAR operations provides radio communications and distress alerts at high speed with the integration of satellite and terrestrial communication means that when vessels sink it can be traced through satellite identification by means of EPIRB. In the following Chapters principles of GMDSS, operations and communication with satellite and terrestrial systems will be discussed further.

Table 2: Tuvalu summary of progress towards implementation of GMDSS

Master Plan	A1 Area	A2 Area	A3 Area	NAVTEX	SafetyNET
No	No	No	No	No	No

Source: Parker & Mundy (2016).

Figure 2: Basic concept of GMDSS.



Source: ICSELECTRONICS, (n.d).

2.7.2 The requirements to establish GMDSS in Tuvalu

It is important to set up GMDSS in Tuvalu and the following reasons to justify the need to implement:

- Several radio equipment are malfunctioning and beyond repair and there are no elements of GMDSS in Tuvalu;

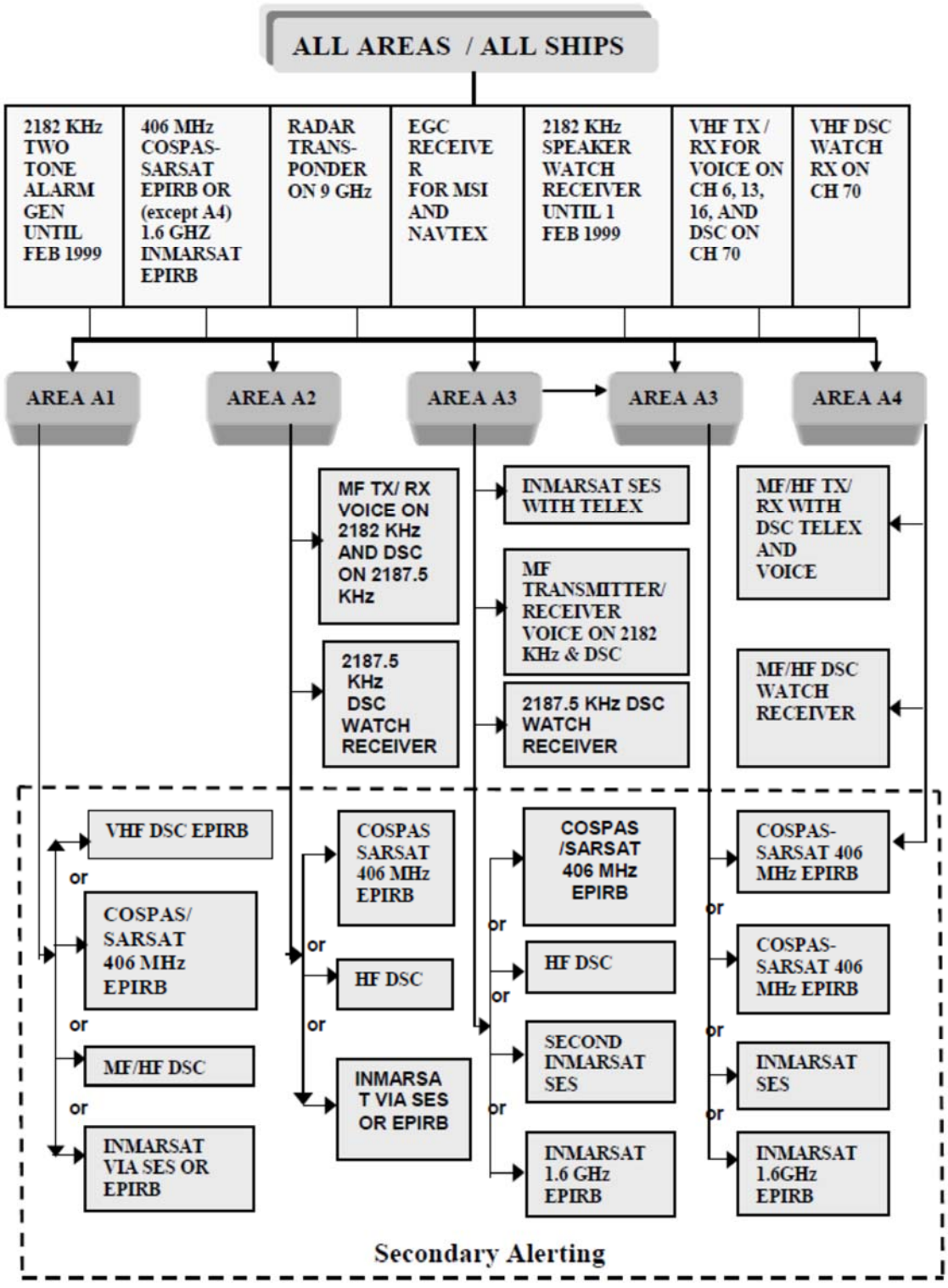
- The coastal and international shipping have communication problems with coast radio station and affects the promulgation of maritime safety information;

- In accordance with the requirement to establish the SAR provisional plan a GMDSS set up is mandatory before adopting the SAR convention.

2.7.3 Operational areas and functional requirements

Basically, GMDSS function is to send and receive maritime safety information and distress alerts through a medium via satellite or radio communication equipment. It also specifies that certain radios can only be used in relation to a ships area of operation and this guide has been put together to explain sea areas A1, A2, A3 & A4 and what type of radios can be used (ICOM, 2019). The chart in Figure 3 shows the sea area carriage requirements for GMDSS.

Figure 3: Sea areas carriage requirements for GMDSS



Source: Alexander, (1999).

2.7.4 Communication function in GMDSS

The Titanic disaster sustained massive lives lost of more than 1600 persons on the 14th April 1912 as a consequence of delay in relaying distress messages across for rescue. Obviously, wireless communication was the only way of distress alerting during the incident as there are limitations notably in terms of distance and conditions of the area. Today, the GMDSS is an integrated communications system which should ensure that no ship in distress can disappear without trace, and that more lives can be saved at sea. This Chapter will discuss GMDSS communications functions as required by regulation IV/4. These functions are individually performed by radio subsystems.

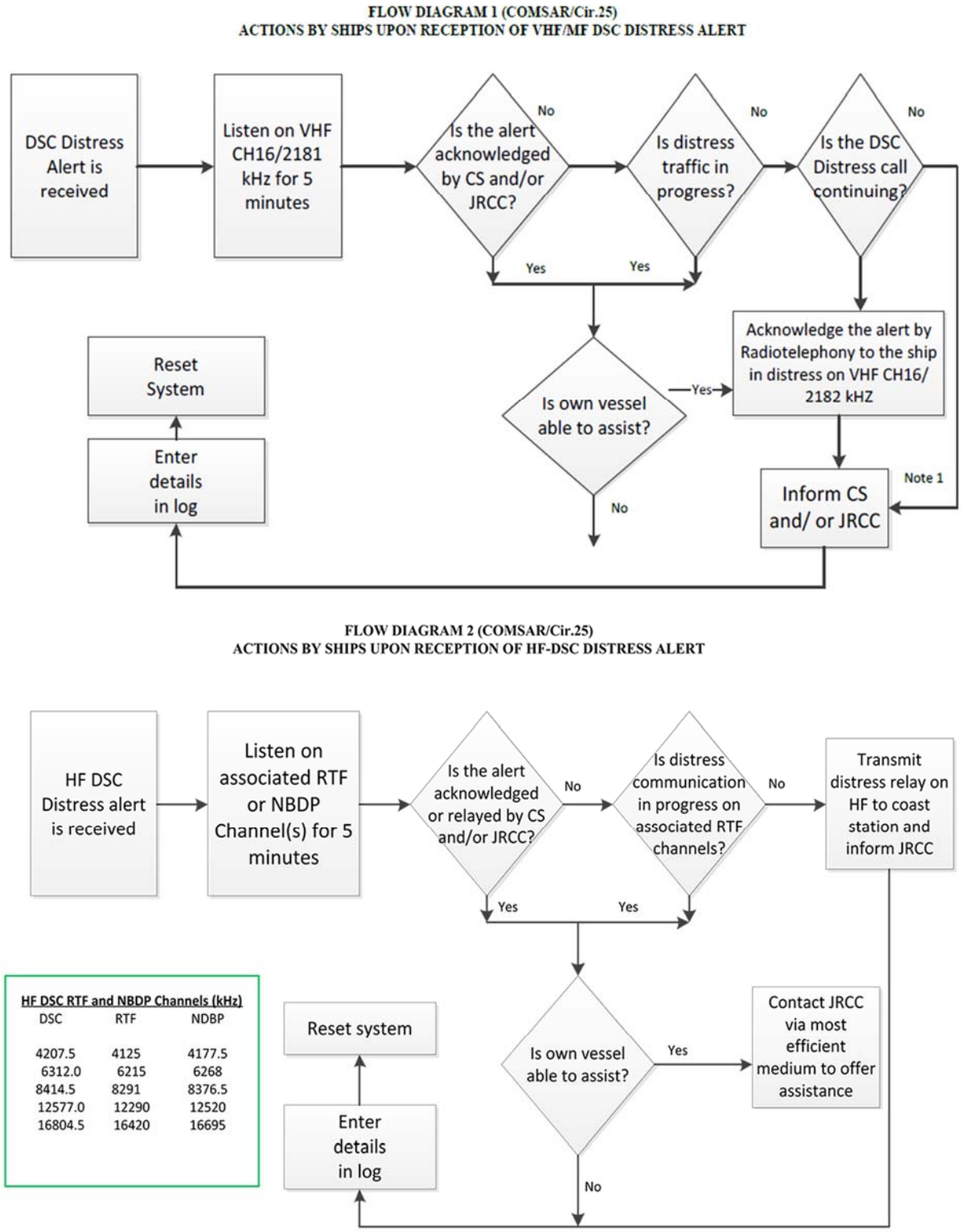
2.7.5 Introduction to sending and receiving distress alerts

Search and rescue operations cannot be successfully carried out without radio communications. In the mid 1890 Marconi developed the first apparatus for long distance radio communication invented a wireless telephony and it came to be used in maritime distress communication on 3rd march 1899 when a freighter rammed the East Goodwin Lightship which was anchored ten miles offshore from Deal in the Straits of Dover off the south east coast of England and help was dispatched.

Distress alerting is the successful and rapid reporting of an incident to RCCs and vessels in the vicinity to coordinate and render immediate assistance without any delay. When an alert is received by the RCC via a coast station or land earth stations, the RCC will relay the alert to SAR units and ships in the vicinity of the distress incident.

The chart in Figure 4 shows how to send and receive distress alerts in GMDSS communications.

Figure 4: Sending and receiving distress alerts in GMDSS communication



Source: Canada Coast Guard, (2019).

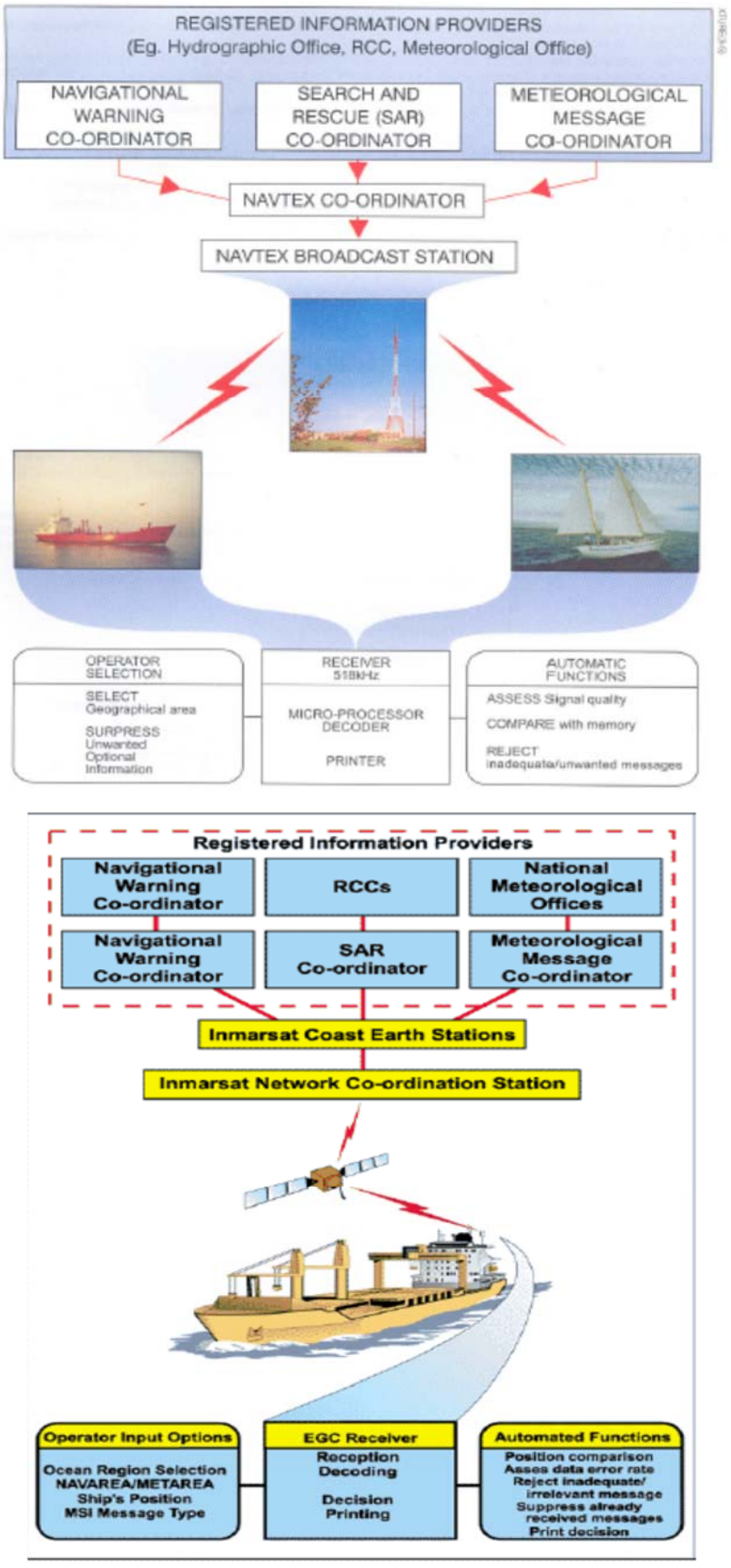
2.7.6 Locating

Locating is the finding of a ship/aircraft in distress or its survival aircraft or survivors, as defined by regulation IV/2.1.8. In the GMDSS this function is performed by means of 9 GHz SAR radar transponders (SARTs) or on AIS-SART carried by the ship in distress or its survivors. The position is indicated when the SART is interrogated by the searching unit's 9GHz radar or displayed by AIS searching unit. Use of the frequency 121.5 MHz in satellite EPIRB is provided for homing by aeronautical SAR units (IMO, 2017). The carriage requirement for SART according to SOLAS convention requires all passenger and cargo vessels over 500 GRT to carry 2 SART and under 500 GRT should carry one SART. "In accordance with the efficiency requirements of the SOLAS convention, SARTs are equipped with a battery, with a capacity of working 96 hours in Standby Mode and 8 hours in continuous transmit mode" (EGMDSS, n.d).

2.7.7 Promulgation of maritime safety information

Ships need to be provided with up-to-date maritime safety information in regards to navigational and meteorological warnings. GMDSS regulation IV/2.1.7 provides for urgency and safety communications and the dissemination of maritime safety information (navigational and meteorological information) to ships (IMO, 2017). Tuvalu falls within NAVAREA XIV. LINZ is the NAVAREA coordinator and broadcasts navigation warnings via SafetyNET for Tuvalu (Parker & Mundy, 2016). Two systems illustrated in Figure 5 are used for broadcasting MSI.

Figure 5: NAVTEX and SafetyNET broadcasting MSI



Source: Budhal, (2006).

2.8 Communication systems in the GMDSS

The Satellite and Terrestrial communications systems provides links between RCC and ship stations for SAR communications. The Satellite communication system provides communication capabilities spanning long distances, operates under conditions which are inoperable for other forms of communication (Techopedia, 2019) and particularly important elements in the operation of GMDSS. Terrestrial communications provide Digital Selective Calling (DSC) alerts in distress and safety communications by radiotelephone or direct-printing telegraphy or both.

In Figure 6 and Table 3 illustrate the GMDSS communication functions and distress alerting communication frequencies mainly for conduct of SAR operations.

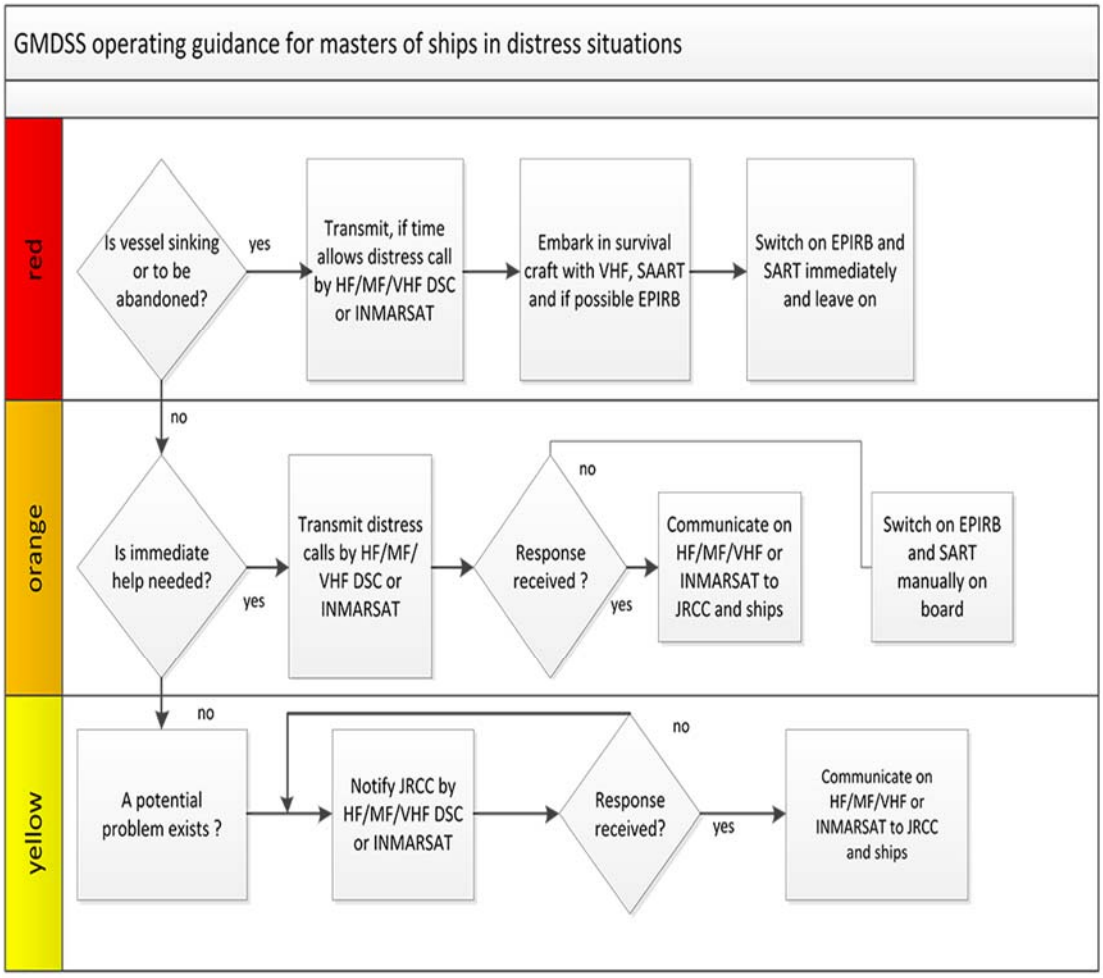
2.9 COSPAS-SARSAT System

The COSPAS-SARSAT system provides humanitarian support around the clock anywhere on earth for 365 days that uses satellite to locate and detect emergency beacons carried by aircraft, ships or individuals by the use of a 406 MHz beacon. When an emergency beacon is activated the satellite system received the signal and relayed to the nearest ground station often called a Local User Terminal processes the signal and calculates the position from which it originated.

This position is transmitted to a mission control center where it is joined with identification data and other information on that beacon. The mission control center then transmits an alert message to the appropriate rescue coordination center based on the geographic location of the beacon. If the location of the beacon is in another country's area of responsibility, then the alert is transmitted to that country's mission control center.

(Source: GMDSS Manual, 2017)

Figure 6: GMDSS communication functions



Source: Coast Guard Canada, (2019).

Table 3: Guidance for distress alerting communication frequencies

Distress and communication frequencies			
	DSC	**Radiotelephony**	**NBDP**
VHF	Channel 70	Channel 16	
MF	2187.5 kHz	2182 kHz	2174.5 kHz
HF4	4207.5 kHz	4125 kHz	4177.5 kHz
HF6	6312.0 kHz	6215 kHz	6268.0 kHz
HF8	8414.5 kHz	8291 kHz	8376.5 kHz
HF12	12577.0 kHz	12290 kHz	12520 kHz
HF16	16804.5 kHz	16420 kHz	16695 kHz

Source: IMO, (2017).

(Guidance for Masters of Ships in Distress)

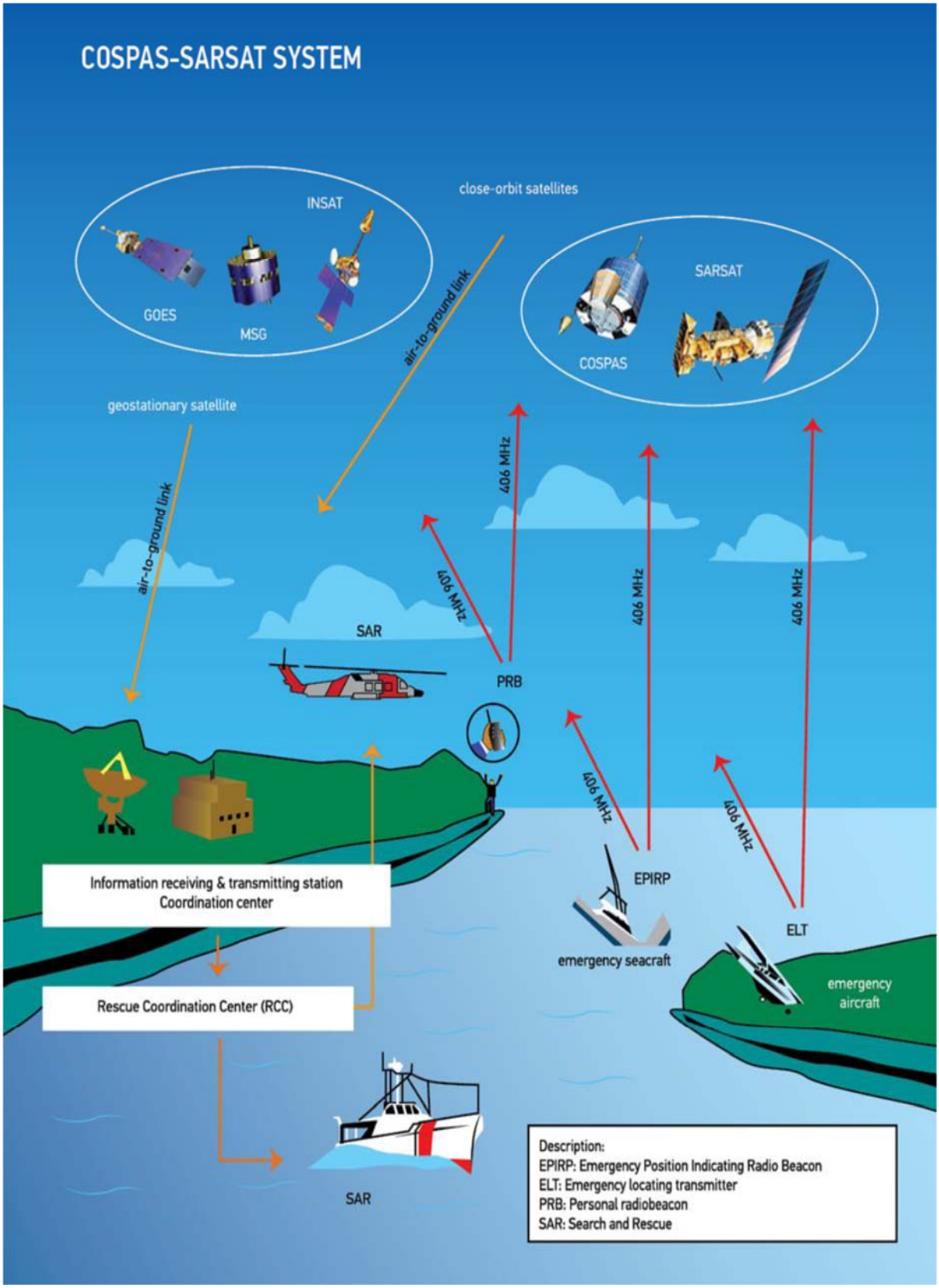
2.9.1 The basic concept of the system

The basic COSPAS-SARSAT system concept is given in Figure 7. There are three types of satellite beacons, namely emergency locator transmitters (ELTs) airborne, EPIRB (maritime) and PLB (personal locator beacons) on land. These beacons transmit signals that are detected by COSPAS-SARSAT satellites polar orbiting spacecraft equipped with suitable receivers/processors. The signals are then relayed to a ground receiving station, called a Local User Terminal (LUT), which processes the signals are decoded to determine the location of the beacon.

An alert is then relayed, together with location data and other information, via a mission control center (MCC), either to a National Rescue Co-ordination Center (RCC), to another MCC or to the appropriate search and rescue authority to initiate SAR activities. The Doppler location concept provides two positions for each beacon: the true position and its mirror image relative to the satellite ground track. This position ambiguity is resolved by calculations that take into account the earth's rotation. If the beacon frequency stability is good enough, the true solution can be determined over a single pass.

(Source: GMDSS Manual, 2017).

Figure 7: Basic concept of COSPAS-SARSAT system



Source: Morsviazsputnik, (2019).

2.9.2 Space Segment

COSPAS-SARSAT system utilize SAR instrumentation on satellites in (LEOSAR) Low-altitude Earth Orbit and (GEOSAR) Geostationary Earth Orbit, including the forward and return communication links with the earth. The equipment on board the satellite consists of the following basic sub-assemblies a 406 MHz received processor and memory unit and 1544.5 MHz downlink transmitter.

The functions of the receiver/processor are as follows:

- Demodulating the digital messages received from beacons;
- Measuring the received frequency; and
- Time-tagging the measurement.

2.9.3 Local User Terminal and Mission Control Centre

There are two types of LUTs that operates with LEOSAR satellite constellation LEOLUT and GEOSAR satellite constellations GEOLUT both process 406 MHz only. In order to meet the specific requirements of countries each LUT configuration and capabilities shall be varied. The COSPAS-SARSAT satellite downlink signal formats ensure interpretability between the various satellite and all LUTs meeting (COSPAS-SARSAT) specifications. The capability of a LEOLUT is determined by the LEOSAR satellite channels it was designed to process. Both 406 MHz Search and Rescue Processor (SARP) transmit received data and Search and Rescue Repeater (SARR) receives the transmission to retransmit on the satellite downlink.

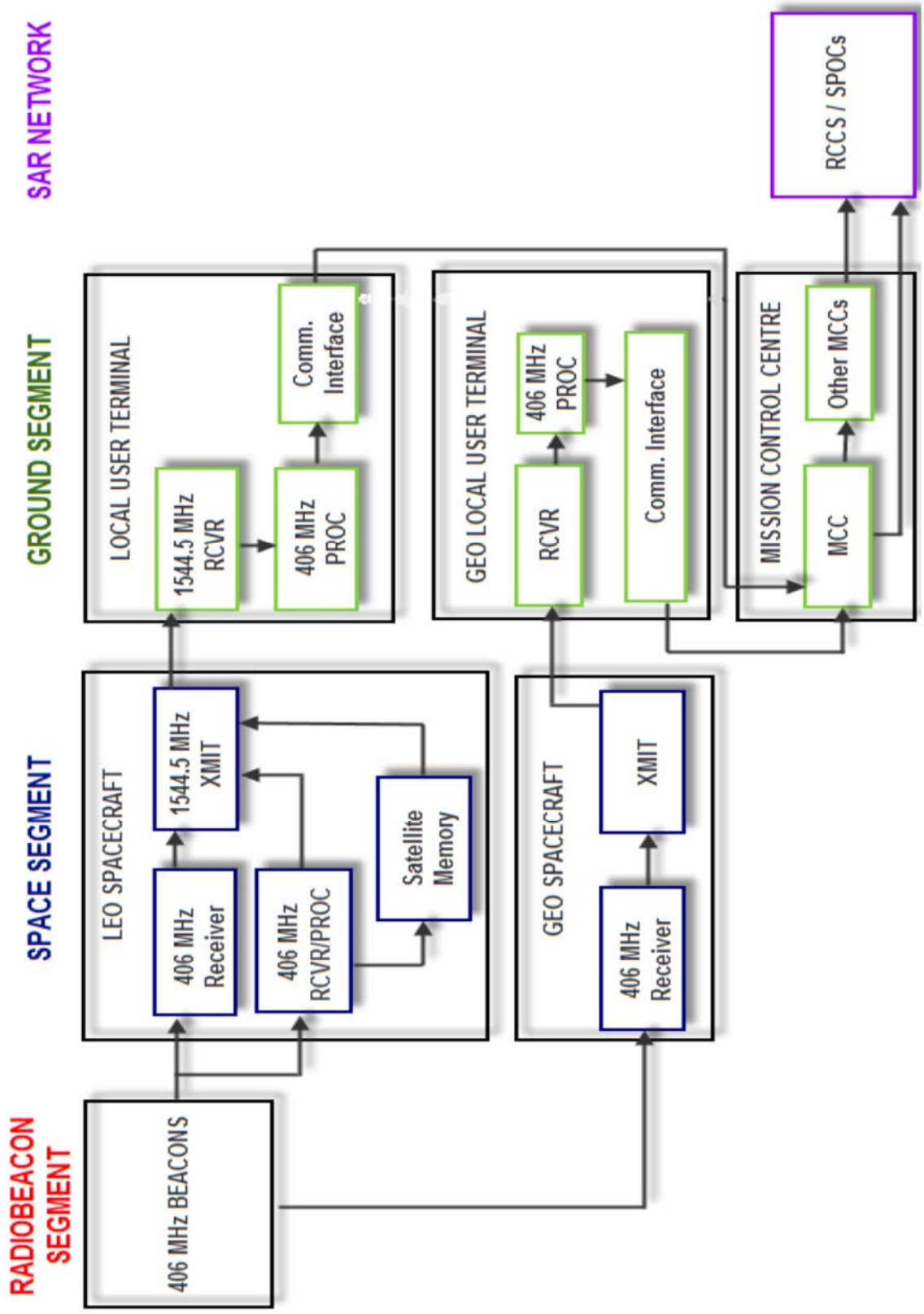
LUT functions are as follow:

- To provide reliable distress alerts and location data to SAR communities;
- To ensure alerts are used and distributed without limitations.

(Source: GMDSS Manual, 2017)

Mission Control Centers have been set up in most countries operating at least one LUT. MCCs main functions are to collect, sort and sort the data from LUTs and other MCCs, provide data exchange within the COSPAS-SARSAT system and to provide data to SAR networks. Figure 8 shows the block diagram distribution of radio beacon/space/ground segment interfaces.

Figure 8: System block diagram and radio beacon/space/ground segment interfaces



Source: COSPAS-SARSAT, (2014).

CHAPTER THREE: TUVALU OVERVIEW AND PACIFIC SAR

3.1 Tuvalu – Background Information

The purpose of this chapter is to give a brief overview of the different elements of Tuvalu relevant to the study, the maritime structure, economy, tourism, fisheries, demography, geographic location with climatic conditions all these factors contribute substantially to SAR incidents. The main focus will be developing SAR in Tuvalu to be fulfilled in identifying the weaknesses in the maritime settings and performing a gap analysis to enhance the level of response to saving lives within Tuvalu EEZ but also to strengthen the Fiji SRR as our position remains in Fiji SAR area. Notably, the presence of commercial and fishing vessels within our EEZ is an issue that was never addressed in the beginning that is when this initiative of adopting the SAR convention became a reality for Tuvalu.

3.1.1 Demography

According to the GOT Population and Housing Census (2012) the population of Tuvalu in the last 20 years from 1992 to 2012 is increasing continuously reaching 10,837 from 9,043 people in Table 4 below.

Table 4: Summary of Tuvalu population from 1991 to 2012

Island	1991	2002	2012
Funafuti	3839	4492	6194
Nanumea	824	664	556
Nanumaga	644	589	481
Niutao	749	663	606
Nui	606	548	541
Vaitupu	1202	1591	1565
Nukufetau	751	586	540
Nukulaelae	353	393	324
Niulakita	75	35	30
Tuvalu	9043	9561	10837

Source: GOT, (2012).

3.1.2 Geographic Information and Maritime Boundaries

Tuvalu have a total land area of 25.6 square kilometers (GOT, 2012) and stretches in a north-south direction over 560 kilometers to the north about 1400 km is the Republic of Kiribati and to the south, 1100 km is the Republic of the Fiji Islands (GOT, 2010). There are nine group of islands forming Tuvalu from north to south:

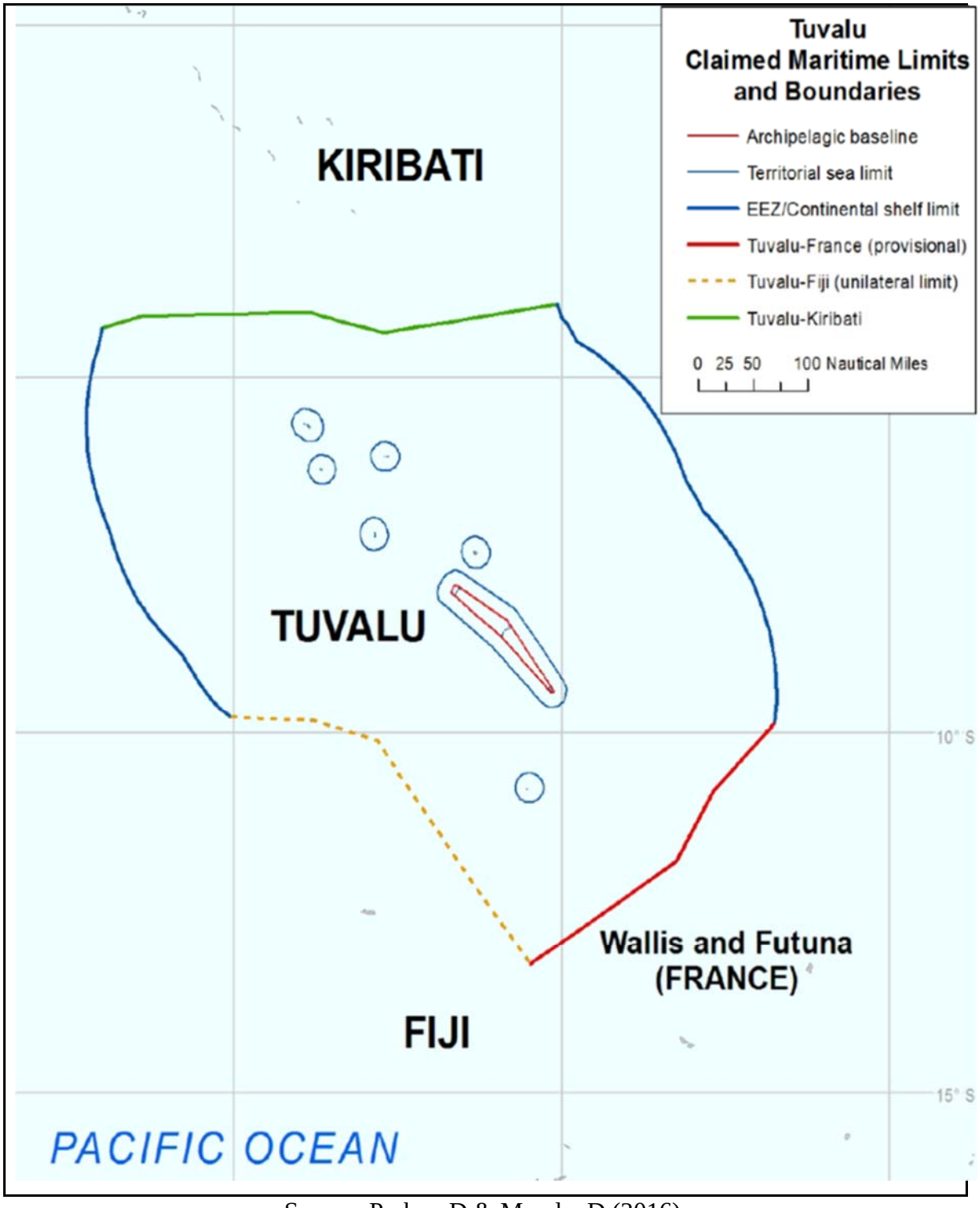
1. Nanumea;
2. Nanumanga;
3. Niutao;
4. Nui;
5. Vaitupu;
6. Nukufetau;
7. Funafuti;
8. Nukulaelae;
9. Niulakita.

Tuvalu EEZ illustrated in Figure 9 covers an area of 900,000 square kilometers (FAO, 2012) and “the main challenge in this area is the lack of human and financial capacity to formally delimitate Tuvalu’s EEZ, fully domesticate the UNCLOS into legislation, and to ensure surveillance and proper management of its marine resources within its waters” (GOT, 2016).

3.1.3 Kaupule Island Council

Tuvalu is a constitutional monarchy inherited a Local government system from the Local government ordinance 1996. This Local government system formed the Kaupule Island Council for each of the eight main inhabited islands excluding Niulakita by which jurisdiction is limited to the island itself. The Kaupule Island Council provide available resources and development of the needs of each island communities and while other services are provided and funded by the national government.

Figure 9: Tuvalu Exclusive Economic Zone



Source: Parker, D & Mundy, D (2016).

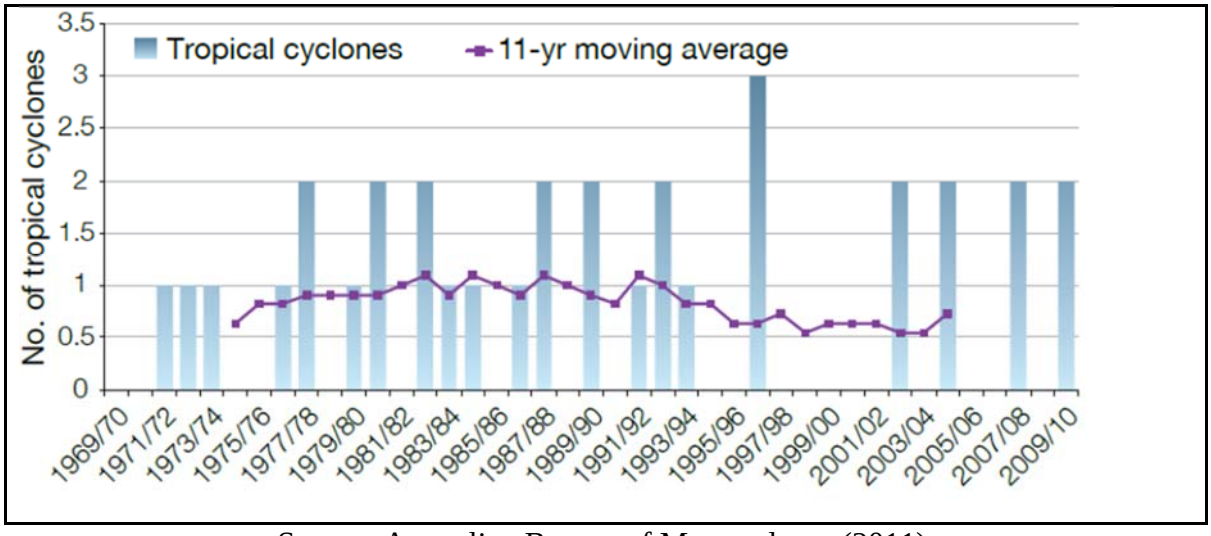
3.1.4 Climate

Maritime accidents are often caused by poor weather conditions and increases the complexity of conducting SAR operations but not for the well trained and skillful individual. Tuvalu has a tropical climate and it is characterized by two distinct seasons:

- a wet season from November to April; and
- a dry season from May to October.

This seasonal cycle is strongly influenced by the South Pacific Convergence. Tuvalu is particularly vulnerable to cyclone-generated winds, storm surges and swells, as well as spring tides (GOT, 2015). In Figure 7 below illustrated the 41 year period between 1969 and 2010, 33 tropical cyclones passed within 400 kilometers of Funafuti, an average of just under one cyclone per season. Over this period, cyclones occurred more frequently in El Nino years (ABM, 2011).

Figure 10: Number of cyclones passing Funafuti from 1969 to 2010



Source: Australian Bureau of Meteorology, (2011).

3.1.5 Economy

Tuvalu was admitted in the LDC category in 1986 (UNCTAD, 2012) because of its limited potential for economic development. As a results GDP growth is highly variable from year to year largely dependent on external factors (GOT, 2016). Tuvalu needs funding as it does not have financial capacity for SAR development within its EEZ, to provide the relevant resources and support required.

3.1.6 Tourism

There had been positive trend increase of Tourists arrivals in Tuvalu as an increase fueled mainly by a dramatic spike in arrivals from overseas countries (SPTO, 2016). SAR response to render assistance in any marine tourism related activities around Tuvalu coast and within its EEZ shall be addressed in SAR planning and coordination. According to the South Pacific Tourism organization (2016) report in “2015 to 2016 there are around 2344 to 2465 tourists active in Tuvalu”.

3.1.7 Fisheries

The conduct of maritime search and rescue involves both accidents onboard vessels and distressed persons at sea. Tuvalu is increasing the presence of FFV within its EEZ by issuing fishing licenses to foreign companies (GOT, 2010) and domestic fishing in Tuvalu waters is mainly for subsistence or commercial use. Virtually all households participate in subsistence activities in the inshore fishery (GOT, 2016). There are 1,417 vessels from 2014 to 2018 engaged in fishing operations within the Tuvalu EEZ (GOT, 2018) which consist of:

- 63 per cent are purse seiners; and

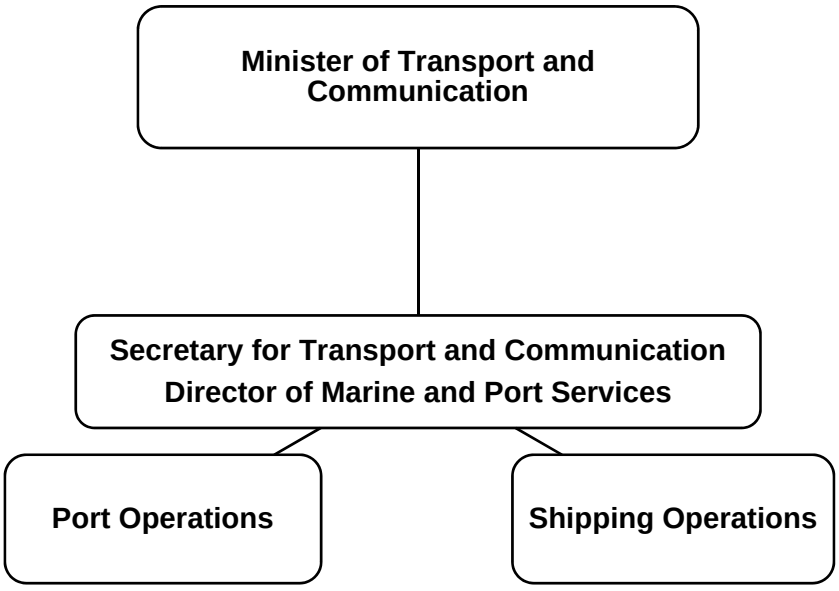
- 37 per cent including Long liner, Bunker and Fish Carrier

3.1.8 Government of Tuvalu Maritime Administration

The Minister of Transport and Communication is empowered by the Tuvalu merchant shipping act to enforce IMO instruments and make regulations for maritime safety and protection of the marine environment. The MCT Government of Tuvalu maritime administration implement and enforce the regulations embodied in the Tuvalu marine shipping act 2008.

The main priorities of the GOT ministry of transport and communication set targets to maintain IMO white listing as a member state and enhance collaboration with regional organizations and states to promote sustainable shipping, improve maritime safety and protection of the marine environment. There are two infrastructures in the Tuvalu maritime transport sector and the MCT organization structure provided below in Figure 11:

Figure 11: GOT MCT Organization structure



Source: Author's own work.

The government of Tuvalu Maritime Administration have adopted and is a signatory to the following International Maritime Organization Conventions (TSR, 2018 & IMO, 2019):

1. International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended;
2. Protocol of 1978 relating to SOLAS 1974;
3. Protocol of 1988 relating to SOLAS 1974;
4. Convention on the International Regulations for Preventing Collisions at Sea (COLREG), 1972;
5. International Convention on Standards of Training, Certification and Watch-keeping for Seafarers (STCW), 1978, as amended;
6. International Convention for the Prevention of Pollution from Ships (MARPOL), 1973;
7. Protocol of 1978 relating to MARPOL 1973;
8. Protocol of 1997 relating to MARPOL 1973, as modified by the Protocol of 1978 Relating Thereto;
9. Maritime Labour Organization (MLC), 2006;
10. International Convention on Load Lines, 1966, as amended;
11. Protocol of 1988 relating to LOAD LINES 1966;
12. International Convention on Tonnage Measurement of Ships, 1969;
13. International Convention on Civil Liability for Oil Pollution Damage (CLC), 1969;
14. Protocol of 1976 relating to CLC 1969;
15. Protocol of 1992 relating to CLC 1969;
16. International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (FUND), 1971;
17. Protocol of 1992 relating to FUND 1971;
18. Convention on Limitation of Liability for Maritime Claims (LLMC), 1976;
19. Protocol of 1996 relating to LLMC 1976;
20. Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation (SUA), 1988;
21. International Convention on Civil Liability for Bunker Oil Pollution Damage, 2001;
22. International Convention on the Control of harmful Anti-Fouling Systems on ships, 2001;
23. International Convention for the Control and Management of Ship's Ballast Water and Sediments, 2004;
24. Nairobi International Convention on the Removal of Wrecks, 2007.

National Strategies and Policies of the marine administration

The Tuvalu maritime administration divided into three departments strategic policy is 'to provide direction to ensure maximum endurance of waterway and port infrastructure in Tuvalu through cost-effective management and timely management'. Key performance targets are outlined below (GOT, 2012):

- Maintain Tuvalu on IMO "White List";
- Maritime Legislation reviewed;
- Procedures on registration of Ships upgraded and strengthened between consulate, classification societies and maritime administration on Funafuti.

Tuvalu maritime administration key performance targets

The maritime administration focus incorporating IMO instruments into national legislation, law enforcement, management of services to meet international maritime standards. To meet intended outcomes of the maritime administration set targets on the following objectives (GOT, 2012):

1. Adhering to International Conventions;
2. Maritime legislation updated;
3. Improved and up to date registration of Ships;
4. Proper registration and certification of seafarers.

Shipping operations key performance targets

The shipping operations department is responsible to provide reliable, safe and affordable shipping services to the outer islands. The key performance targets are (GOT, 2012) to:

- Provide proper and safe shipping services for all passengers and cargo;
- Maintain vessel standard to acceptable levels.

3.1.9 Functions of the marine administration in SAR operations

The maritime administration has a role within the government of Tuvalu ministry of transport and communication to enforce IMO conventions embodied into a national legislation the Tuvalu merchant shipping act 2008. Under the revised national legislation the following conventions have been incorporated, the STCW convention, SOLAS convention, Tonnage measurement convention, Load line convention, Limitation of liability and collision regulations. The maritime administration as the specialized executive authority within government agencies and public organizations is mandated to implement maritime conventions to promote safety of navigation, protection of human lives and the marine environment from ships pollution and improve the sustainability of shipping and ports.

In regards to SAR operations the most important aspect of the maritime administration is the safety of life at sea which requires Tuvalu as a signatory to the SOLAS convention to form a national SAR organization and plan, coordinate maritime SAR and collaboration with relevant organizations. The most important aspect of SAR is to offer assistance to persons in imminent danger which shall be dealt with maximum speed, efficiency and effectiveness. Tuvalu is in a position to focus on the elements of maritime safety which can be achieved by adopting the three important conventions that states needs to fully adopt and comply with safety regulations provided in:

1. SOLAS convention Chapter V Regulations 7 and 21;
2. SAR convention; and
3. IAMSAR.

3.2 Tuvalu merchant shipping act 2008

The Tuvalu marine act have been superseded by the Tuvalu Merchant shipping act 2008 to deal with maritime related matters which makes provisions for the implementation of IMO conventions upon notice given by the minister. Relevant IMO conventions adopted by the maritime administration given in Chapter 3.2 of this dissertation have not been embodied into the national legislation as drafting of a code requires considerable time and acts should be approved by parliament prior to amending new legislation.

The relevant sections for SOLAS is given in Part III Regulation 47 International Maritime Conventions. A summary of the content of the Tuvalu merchant shipping act is given below:

Part I – Preliminary (Regulation 1 to 3)

This part introduces the act as approved and endorsed by the minister including adaptations to fully enforce and make provisions as appears to be necessary.

Part II – Registration of Ships (Regulation 4 to 46)

This section deals with provisions in relation to registration of ships and is legally binding to the laws of Tuvalu in its conduct of operations. The Registrar of ships is duly appointed to register particulars of ships entered in the Tuvalu Ship Registry and provided that ship owners shall be a qualified person under this act.

Part III – International Maritime Convention (Regulation 47 to 49)

This section deals with relevant provisions for international maritime conventions embodied into the act and sanctions imposed for any non-compliance as penalties.

Part IV – Safety (Regulation 50 to 72)

This section deals with safety aspect of shipping and obligations to assist persons in danger of being lost at sea by the Master of the vessel. Moreover, issues concerning unsafe ships for detention under section 48 and section 50 for any committed offence or non-conformity issues are all mentioned in this part.

Part V – Master and Seamen (Regulation 73 to 120)

This part focus on the maritime labour convention 2006 which provides requirements for Masters and crew social welfare and living conditions aboard a vessel. Statutory requirements for Master and Crew to comply with STCW convention concerning competencies and contract of employments.

Part VI – Division of liability (Regulation 121 to 124)

This part refers to the rule of division of liability to make good the damage or loss caused shall be in proportion to the degree in which each ship was in fault.

Part VII – Legal proceedings (Regulation 125 to 130)

This part of the act set jurisdictions on offenses committed onboard ships and limitation of actions.

Part VIII – General (Regulation 131 to 141)

This part deals with making declaration required by the Act to be made to the Registrar of Ships and any willful or making a false statement is guilty of an offense.

3.3 Port Services

Maritime transport improves economic development and Port services in Tuvalu connects passengers to the outer islands and to the outer world which is also an interface with local and international shipping receiving import and export cargoes. As the closest neighbor to Fiji and other Pacific Islands, Tuvalu directly benefit from regional and international trade in commercial shipping and fisheries operations. The only Funafuti port in Tuvalu provides berthing of container, bulk, fishing, tanker, cruise liners, yachts, cargo and passenger vessels. Funafuti harbor consists of a dredged basin with two finger wharves and it complies with international standards and port state control requirements (GOT, 2012). The Port of Funafuti have been visited by vessels provided in the trade and maritime traffic statistics in Table 5 below.

Table 5: Trade and maritime traffic information from 2013 to 2016

Type	Year			
	2016 (to Nov)	2015	2014	2013
PURSE SEINER	77	194	49	7
LONG LINER	0	0	2	2
CONTAINER	14	24	22	18
GENERAL CARGO	5	9	13	21
BARGE	1	5	0	1
FISH CARRIER	12	34	0	0
MOTHER SHIP	13	1	15	3
TANKER	5	5	5	6
TUG BOAT	2	3	0	0
NAVY VESSEL	1	4	1	1
CRUISE SHIP	0	1	1	0
REEFER / FISH CARRIER	12	60	5	0
MISC	1	4	11	2

Source: Parker, D & Mundy, D (2016).

The above trade and maritime traffic information shows that there is a dramatic increase of port traffic from 2013 to 2015 which shows only traffic data in port but excluding fisheries and commercial operations in the inshore waters and EEZ which is more compared to the above. Shipping and fisheries operations occupies Tuvalu maritime zones all year round with great concern that in any circumstance a SAR incident eventuates the position of Tuvalu to provide SAR response and coordination is very limited.

Funafuti port does not have adequate manpower capacity, GMDSS resources and short range communication facilities to provide port and maritime traffic updating and coordination of vessels moving into the port. The promulgation of MSI is also restricted due to breakdown and unavailability of standard radio communication facilities therefore increases the risks of hazards to navigation for vessels within Tuvalu maritime zones. In the Port operations there are limited radio communication systems and are not maintained according to technical standards.

The Radio operators are not qualified and well trained to maintain and perform radio communication procedures to vessels around the port and broadcast safety information. On that reason, the Port is very weak to perform its responsibilities to promote maritime safety through radio communication and GMDSS monitoring. Radio communications are transmitted only when position updating reports are required by government vessels.

3.4 Government Fleet Shipping Services

The main focus for shipping in Tuvalu is domestic and international trade. The outer islands are reliant on delivery of cargo and passengers by sea from Funafuti, and the government have developed port facilities and vessels to provide for the demands in shipping. There are approximately 235 passenger arrivals internationally each year by boat, and an estimated 4,000 domestic passenger movements (GOT, 2012). The government of Tuvalu shipping fleet consist of two cargo and passenger vessels are also part of SAR mission and operations.

1. SOLAS compliant cargo and passenger vessel;

2. SOLAS Non-compliant cargo and passenger vessel.

3.4.1 Local shipping routes

The government shipping routes serves the local community providing inter island services once a month to the Nine group of islands. These shipping services are often at high risks during peak seasons due to overcrowding, passenger transfer operations are becoming potentially complicated as the intensity of winds increases during hurricanes seasons. The government vessels also substituted the Naval patrol boat in search and rescue operations. Shipping routes are from Funafuti to the eight outer islands Nukufetau, Nui, Vaitupu, Niutao, Nanumaga, Nanumea, Nukulaelae and Niulakita. The distances covered between the islands in Table 6 is relevant in the conduct of SAR operations also considering the vessel speed to reach a distressed call point and the SAR decision support system to deploy UAVs and Helicopter services for increased response to extract casualties.

3.4.2 Distances between the Tuvalu islands

The following distances in nautical miles connecting Funafuti to the outer island group is important in SAR assessment, coordination and performance.

Table 6: Distances between Funafuti and Tuvalu islands

Funafuti	Distance to in (nautical miles)
Nukufetau	70
Nui	145
Vatitupu	69
Niutao	182
Nanumaga	218
Nanumea	251
Nukulaelae	70
Niulakita	133

Source: Authors own work

3.5 Conduct of SAR operations in Tuvalu

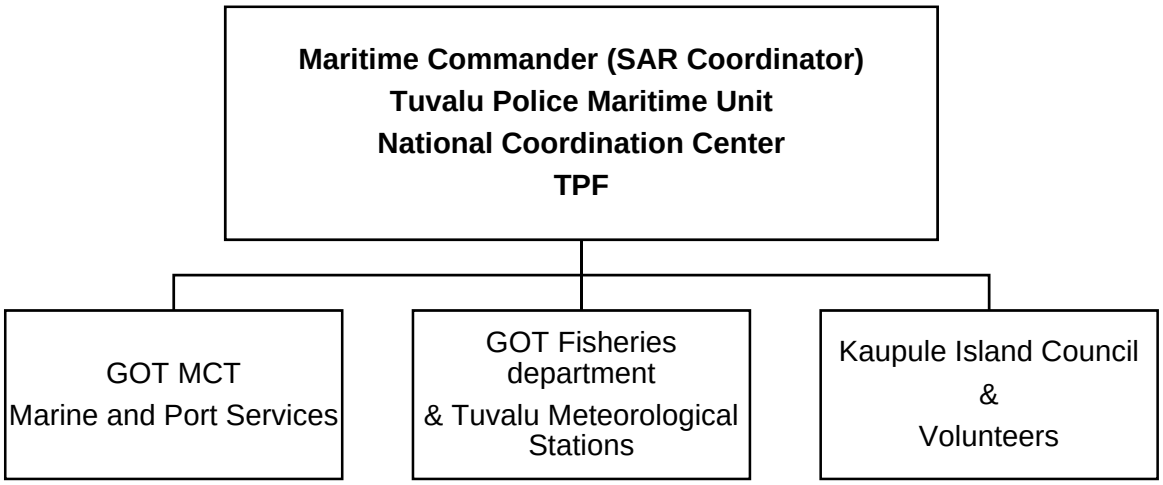
The TPF National Coordination Centre (NCC) aided by aerial surveillance flights provided by RCCNZ and RCC Australia monitor response to maritime SAR within the Tuvalu waters. NCC does not have full capabilities and compliance to facilitate SAR response to international standards. Within the national SAR organizational framework, rescue personnel are limited and the patrol vessel is not fully dedicated for emergency SAR thus restrict the performance of search and rescue. SAR deficiencies according to SPC (2017) states that "there are no maritime safety awareness programs for the public, unavailability of communication and monitoring systems, system and planning tools are not accessible, non-existent of legislation and maritime SAR technical agreement". Although Tuvalu have limited SAR capabilities and resources it been able to rescue distressed persons at sea and coordinated SAR and distress communications at the following standard frequencies and channels.

- VHF Radiotelephony channel 16;
- VHF DSC channel 70;
- MF Radiotelephony 6215 KHz;
- HF Radiotelephony 4576 KHz;
- MF DSC 2187.5 KHz;
- HF DSC 6312 KHz.

3.5.1 Tuvalu National SAR Organization and resources

The importance of saving persons lost at sea have been the norm in the society and traditional practice in Tuvalu as humanity and protection of lives is highly valued considering the limited SAR resources. The conduct of SAR operations in Tuvalu involves the NCC, Tuvalu Police maritime unit, TPF, DMPS, Tuvalu Meteorological Stations, Kaupule Island council, TFD and Volunteers. SAR coordinators and NCC are alerted in the first response to any SAR incident for proper action and planning. The SAR organizational structure, SAR arrangements and description of responsibility is provided below in Figure 12 based on authors own work on the existing conduct of SAR in Tuvalu.

Figure 12: SAR organizational structure



Source: Author's own work

National SAR coordinators:

Upon receiving distress alerts by NCC, Police stations, meteorological stations and vessels within the Tuvalu maritime zones is reported to SAR coordinators:

- Mr Talafou Esekia
  Maritime Commander (SAR Coordinator)
  Tuvalu Police Force Maritime Wing
  Vaiaku, Funafuti,
  Tuvalu.
  Telephone: 688 20156 Fax: 688 20148
  Email: talaloi@yahoo.com.au
- Director of Marine and Port Services (Assistant SAR Coordinator)
  Mr Taasi Pitoi
  Ministry of Transport and Communication,
  Government of Tuvalu,
  Vaiaku, Funafuti,
  Tuvalu.
  Telephone: 688 20055 Fax: 688 20722
  Email: taasi.pitoi@gmail.com

According to the maritime SAR 1979 convention (2000) states should "ensure the provision of adequate shore-based communication infrastructure, efficient distress alert routeing, and proper operational coordination to effectively support search and rescue services". South Pacific Commission (2017) Tuvalu National SAR resources and response are only limited to:

1. Tuvalu Patrol Boat with established communication systems;
2. National Coordination Center (Shore-based) and Tuvalu Police Force personnel;
3. GOT MCT passenger and cargo vessels (2);
4. GOT TFD and Fisheries vessels (2);
5. Kaupule Island Council;
6. Tuvalu Meteorological Stations;
7. Volunteers.

3.5.2 National Coordination Center and Tuvalu Police Force maritime unit

By virtue of its small size, Tuvalu does not have a dedicated SAR organization and resources to coordinate mass rescue operations and relies entirely on larger, established countries such as Fiji, Australia and New Zealand to provide SAR assistance. Through the Pacific Patrol Boat program a development project initiative for Small Island Developing States (SIDS), Australia has donated a patrol boat for Tuvalu primarily for the purpose of protecting its exclusive economic zone from illegal fishing activities and augmented by the provision of a Vessel Monitoring Service (VMS) by the Pacific Forum Fishing Agency (FFA).

VMS is aided by a satellite-based device which monitors FFA registered fishing vessels position, speed and course over ground tracking and monitoring fisheries activities across the pacific region. In collaboration with Australian and New Zealand naval vessels, the Tuvalu Patrol Boat HMTSS Te Mataili participates in boarding operations of foreign fishing vessels (FFV). The Police maritime unit is responsible for the operation of HMTSS Te Mataili with assistance and oversight of the Australian In-country regional Maritime Surveillance Advisor (MSA), a position in the Royal Australian Navy.

The NCC based in Funafuti at the TPF headquarters was established by a joint venture by the Tuvalu Fisheries Department and the Tuvalu Police maritime unit to monitor and coordinate fisheries operations, VMS, search and rescue operations, protection of the marine environment and EEZ from IUU fishery activities, general law enforcement and compliance duties, which encompass all the government maritime affairs. TFD and Police on-duty manned the NCC. TPF maritime unit is in charge of search and rescue and the deployment of the Tuvalu Naval Patrol boat for any SAR mission. All search and rescue within Tuvalu EEZ is the responsibility of the TPF maritime unit and is coordinated by the NCC SAR coordinator. There are also Police sub-stations on the outer islands which are also part of search and rescue mission response coordinated by NCC.

3.5.3 NCC search and rescue resources

The following SAR radio communication equipment are used for SAR monitoring and response within the NCC.

- Direct line Telephone number: +688 20101;
- Fax: +688 20820;
- VHF RT/DSC;
- MF/HF Distress watch-keeping receivers (4576/6215 KHz);

Tuvalu Police Force outer Islands Sub-stations

Table 7: Tuvalu outer Islands radio frequencies

Station	Call sign	MF/HF RT Frequency	VHF channel
Nanumea	Nanumea Police station	4576/6215 KHz	16/14
Nanumaga	Nanumaga Police station	4576/6215 KHz	16/14
Niutao	Niutao Police station	4576/6215 KHz	16/14
Nui	Niu Police station	4576/6215 KHz	16/14
Vaitupu	Vaitupu Police station	4576/6215 KHz	16/14
Nukufetau	Nukufetau Police station	4576/6215 KHz	16/14
Nukelaelae	Nukulaelae Police station	4576/6215 KHz	16/14

Source: Authors own work

3.5.4 Naval Boat used for search and rescue

The Tuvalu Naval Guardian Class Patrol Boat HMTSS Te Mataili II is equipped with GMDSS equipment capable of responding to SAR radio communication standards (Austal, 2016).

- VHF/DSC Radio;
- MF/HF DSC Radio;
- VHF Aero-band Radio;
- UHF Military Radio;
- Inmarsat C SatCom;
- HF Radio Direction Finder;
- VHF Radio Direction Finder.

3.5.5 Marine and port services communication systems

Funafuti Port

Call sign: Funafuti Port Control

- MF/HF Radiotelephony frequency (4576/6215 KHz);
- VHF channel 16;
- VHF DSC channel 70;
- MF DSC;
- HF DSC.

MCT Cargo and Passenger vessels used for SAR operation:

MV Nivaga III

- Inmarsat C;
- DSC Radio transceiver;
- MF/HF Radio;
- VHF Radios;
- GMDSS VHF Radios;
- NAVTEX receiver;
- EPIRB 406 MHz;
- SART.

MV Manu Folau

- DSC Radio transceiver;
- MF/HF Radio;
- VHF Radios;
- GMDSS VHF Radios;
- NAVTEX receiver;
- EPIRB 406 MHz;
- SART.

3.5.6 Tuvalu meteorological stations radio equipment

The meteorological weather office located in Funafuti monitors the weather 24 hours 7 days a week. There are three weather sub-stations established at strategic locations in the following islands with MF/HF radio communication systems:

- Northern Island (Nanumea sub-station) MF/HF RT 4576/6215 KHz;
- Central Island (Nui sub-station) MF/HF RT 4576/6215 KHz;
- Southern Island (Niulakita sub-station) MF/HF RT 4576/6215 KHz.

3.5.7 Tuvalu Fisheries Department radio systems

Figure 13: TFD radio systems

Research Vessel (RV Talamoana)	GMDSS System:
Owners: GOT Tuvalu Fisheries Department	DSC Radio transceiver
MF/HF Frequencies:	MF/HF Radio, VHF Radio,
4576 KHz/6215KHz	GMDSS VHF Radio
VHF Frequencies:	NAVTEX receiver
Channel 16/10	EPIRB 406 MHz, SART
Fishing Vessel (FV Manaui)	GMDSS System:
Owners: GOT Tuvalu Fisheries Department	DSC Radio transceiver
MF/HF Frequencies:	MF/HF Radio, VHF Radios
4576 KHz/6215KHz	GMDSS VHF Radios
VHF channel:	NAVTEX receiver
Channel 16/10	EPIRB 406 MHz, SART
Tuvalu Fisheries Department Radio station	Radio-communication system:
Call sign: Funafuti Fisheries	MF/HF Radiotelephony
MF/HF Frequencies:	VHF Radiotelephony
4576 KHz/6215KHz	
VHF channel:	
Channel 16/10	

Source: Authors own work

3.5.8 Designated coast watch stations

The Kaupule Island council are the designated coast watch stations and responsible for SAR coordination equipped with radio communication systems at all Tuvalu outer islands.

Figure 14: Designated coast watch stations

Station	Call sign	Radio-communication system
Nanumea	Kaupule Nanumea	MF/HF RT 4576/6215 KHz VHF channel 16/12
Nanumaga	Kaupule Nanumaga	MF/HF RT 4576/6215 KHz VHF channel 16/12
Niutao	Kaupule Niutao	MF/HF RT 4576/6215 KHz VHF channel 16/12
Nui	Kaupule Nui	MF/HF RT 4576/6215 KHz VHF channel 16/12
Vaitupu	Kaupule Vaitupu	MF/HF RT 4576/6215 KHz VHF channel 16/12
Nukufetau	Kaupule Nukufetau	MF/HF RT 4576/6215 KHz VHF channel 16/12
Funafuti	Kaupule Funafuti	MF/HF RT 4576/6215 KHz VHF channel 16/12
Nukulaelae	Kaupule Nukulaelae	MF/HF RT 4576/6215 KHz VHF channel 16/12
Niulakita	Kaupule Niulakita	MF/HF RT 4576/6215 KHz VHF channel 16/12

Source: Authors own work

3.6 Current search and rescue response system

The following actions are taken by NCC when any sort of distress alert is received:

- Both SAR and Assistant SAR Coordinators informed with SAR response committee to meet at the NCC for briefing and planning;

- The NCC conduct a chronological preliminary investigation taking into account events and actions taken;

- All the agencies concerned within the National SAR organization are informed TPF, TFD, TPF maritime unit, Tuvalu meteorological stations, MCT DMPS, Kaupule Island council and volunteers;

- The maritime commander and commanding officer of the Naval Patrol boat decide which ship to be deployed and informed accordingly, if assistance required for additional vessel for deployment then Head of departments are notified;

- When aerial surveillance is required the Secretary of Foreign Affairs is contacted for arrangements with regional Fiji Airways airline, NZRCC and RCC Australia for assistance.

3.7 Overview of Pacific SAR

The PACSAR steering committee have a significant role in maintaining SRR in the central and south eastern pacific. It is formed of five principal nations Australia, New Zealand, Fiji, France and the United states. The key roles of PACSAR are implementing maritime safety education to the public to promote maritime safety regulations, safe practices in using relevant safety equipment such as PLB, EPIRBS with safety guidelines to mitigate marine SAR accidents at sea.

“A key mechanism of PACSAR is to enhance SAR capability and cooperation across the pacific through hosting a biennial workshop” (PACSAR, 2017). Tuvalu a member of PACSAR will benefit from meetings, to build collaborative relationships and share ideas, knowledge and expertise.

3.7.1 Fiji Search and Rescue

The republic of Fiji is a signatory to the SOLAS convention and UNCLOS with an obligation to establish the SAR convention. Fiji SRR encompasses Tuvalu national SAR region and this study is relevant to identify gaps and to strengthen the SAR capabilities of both countries. Fiji comprised of more than 332 islands, of which 110 are inhabited with a total land area of 18,270 square kilometers (World-atlas, 2019).

The maritime SAR legal framework in Fiji at the national level are the Fiji Constitution 2013 and Disaster management act supported by various organizations in private and public sector such as the Fiji Navy, Public Hospital and ambulance, Police act, civil aviation act and local government act.

Although Fiji is designated for a SRR in the Pacific region, SAR manual and plan are not accessible. For that reason Tuvalu shall move forward to develop maritime search and rescue to strengthen both nations but to remain in Fiji SRR. Fiji maritime SAR capability and response are facilitated by:

- Patrol boats, Air support from local airlines companies;
- Military, Police, Fire services SAR capability (MRCC, ARCC, LRCC);
- Merchant/Fishing vessels, SARIS software;
- MRCC manned 24/7;
- MOUs and partnership program;
- Community response;
- Substantial SAR assets including domestic airlines.

(Source: SPC, 2017)

3.7.2 Search and Rescue in Australia

Introduction

In 1991 the Australian Maritime Safety Authority was established to be the supreme commonwealth authority to promote maritime safety and protection of the marine environment by the Australian Maritime Safety Authority act 1990. The commonwealth of Australia is a signatory of the following ICAO and IMO conventions:

- Convention on international civil aviation 1944;
- International convention for the safety of life at sea 1974;
- International convention on maritime search and rescue 1979.

Australia SRR covers over one tenth of the earth's surface which is over 53 million square kilometers. SAR arrangements in Australia where it covers the Indian, Pacific and Southern oceans, Australian Antarctic territories are influenced by the continent physical land size as the world's sixth largest country. In 1997, AMSA and Air services Australia merged to form the JRCC to coordinate SAR for maritime and aviation incidents. According to AMSA (2018) from 2013 to 2016 a total of 55 maritime SAR incidents were coordinated and most of the accidents are grounding, sinking, fire onboard, capsizing and loss of power at sea.

Australia has established a cooperative SAR arrangement between AMSA, the state and territory police, and the Australian Defense Force. These three organizations make up Australia's SAR authorities, with many other SAR organizations acting in support, including:

- Volunteers;
- Professional SAR practitioners;
- General aviation aircrafts;
- Public;
- Shipping.

(Source: AMSA, 2018)

3.7.3 National search and rescue council

The commonwealth of Australia had set up a centralized search and rescue council responsible for coordinating SAR arrangements and is made up of the following SAR authorities:

1. AMSA;
2. Australian Defense Force;
3. Eight federal, state and territory police services.

The organization was set up in Canberra, Australian capital territory with the role of formulating, discussing and ratifying national SAR policies. NATSAR is responsible for controlling, directing and coordination of maritime and aeronautical search and rescue mission within the Australian SRR. Aims and objectives of NATSAR:

- Establish virtual SAR national center of excellence;
- Establish a risk based approach and authoritative voice on SAR in Australia;
- Provide support and effective coordination between SAR authorities and agencies; and
- Support training issues and standardized approaches to emerging technologies.

3.7.4 The National Search and Rescue Manual

The National search and rescue manual was developed from three international conventions for Australia to meet its international obligations to established standardized and coordinating procedures to promote the safety of life at sea derived from the:

- Convention of International Civil Aviation, 1944 (Chicago Convention);
- International convention of Safety of Life at Sea, 1974 (SOLAS); and
- International Convention on Maritime Search and Rescue, 1979 (SAR Convention).

The objectives of the National SAR manual were based on government and non-governmental organizations common interests and agreements embedded to form policy on SAR administration and operations. Two parts of the policy where civilian search and rescue operations are conducted by AMSA and Australian Defense Force responsible for military ships, aircrafts and personnel when undertaking operations and exercises.

3.7.5 Role of AMSA in search and rescue

The federal government of Australia has set up a national regulatory body to establish IMO conventions dealing with maritime affairs. The Australian Maritime Safety Authority (AMSA) promotes safety of shipping, protection of the marine environment from ships pollution and maintain a national search and rescue service for maritime and aviation sectors. AMSA function required under this framework is to establish the MRCC and SAR arrangements for a 24/7 high tech search and rescue capabilities for maximum distress response across Australia SRR. AMSA response to SAR consist of the following resources:

- Advanced response and satellite technology;
- Contracted equipment;
- Emergency towage vessel; and
- Four Jet aircrafts.

The role of the MRCC is to coordinate search and rescue between federal, state and local authorities including armed and police forces with participating volunteer search groups. The principal function of MRCC is coordinating maritime search and rescue within Australia SRR with the optimal use of available resources to ensure that SAR operations are carried out with maximum speed, efficiency and effectiveness.

Staff operating MRCC are highly qualified in coordinating maritime and aeronautical search and rescue systems as required by IMO and ICAO standards. The MRCC is equipped with COSPAS-SARSAT satellite systems capable of receiving distress alerts from PLB, ELT and EPIRB transmitting on 406 MHz.

The provision of maritime safety information (MSI) through terrestrial VHF/MF/HF RT and DSC radio systems and satellite SafetyNET are available to the public for fishermen, boating enthusiasts and commercial vessels. The MRCC as part of AMSA is responsible for:

- The promulgation of maritime safety information (meteorological, navigational warnings, search and rescue information) in NAVAREA X and METAREA X for vessels. AUSCOAST warnings are broadcast for relevant coastal areas;
- Provide vessel traffic information for navigation safety in coastal waters;
- Provides MASTREP used to track vessels in the SRR and to meet SAR obligations;
- Long–range identification and tracking (LRIT) is a system requiring vessels to automatically transmit their identity, position and the date/time every six hours;
- Provides REEFREP ships reporting system.

(Source: AMSA, 2018)

The Australian Maritime Safety Authority has an effective and efficient framework for marine environmental protection, maritime safety and search and rescue services. AMSA achieved this by applying organization systems and management concepts, improvised maritime satellite technology, monitoring of the performance of the organization, continuous training and development of staff members to meet the objectives and requirements of SAR by IMO, ICAO and Australia as a whole. Australia has helped Tuvalu continually in providing capacity building for SAR training, provision of aerial surveillance and SAR equipment.

The government of Tuvalu in particular the maritime administration will greatly benefit if arrangements for the development of SAR is sorted with AMSA and Australia. This will help in improving clear policy objectives, legislate the legal authority of the SAR organization to coordinate operations of the MRSC, train SAR staff and provide all SAR resources. This will also improve the maritime administration in Tuvalu overall operation and coordination of search and rescue services.

CHAPTER FOUR: RECOMMENDATIONS AND CONLUSION FOR TUVALU

Introduction

The requirement for Tuvalu to provide humanitarian support as member state of IMO and ICAO will help prevent and cope with distress situations and to facilitate international co-operation and co-ordination. As a result of the weakness and defective SAR, it is imperative that GOT must deliver and coordinate the delivery of SAR services with neighboring countries in particular Fiji and collaborate with international organizations. This chapter will discuss recommendations and conclusion for the development of SAR in Tuvalu. Structured accordingly to enact and implement national SAR legislation, national SAR plan, national SAR organization, MRSC, SAR support systems, manage and coordinate SAR operations.

4.1 Proposal for legislation and framework on SAR

The government of Tuvalu draw less attention to the formation of a well performed and organized SAR framework and organization structure because of the low frequency of marine incidents and the obligations exerted on coastal states to meet certain international requirements. “Search and rescue of a person in distress at sea on humanitarian grounds with or without the international obligation is a common duty for mankind” (Tun, 2000).

Tuvalu’s primary maritime legislation is contained in the *Tuvalu merchant shipping act 2008*. The legislation is comprehensive, which contains eight parts and the part three incorporates the international maritime conventions adopted by the government of Tuvalu which includes SOLAS convention. Although presently Tuvalu has not adopted SAR convention the assistance and rescue of distress person at sea has always been rendered within its area of jurisdiction.

Tuvalu as a signatory of the SOLAS convention is obliged to establish a SAR organizational structure under the provisions of Chapter V Regulation 7 as a requirement for every contracting government to provide search and rescue services.

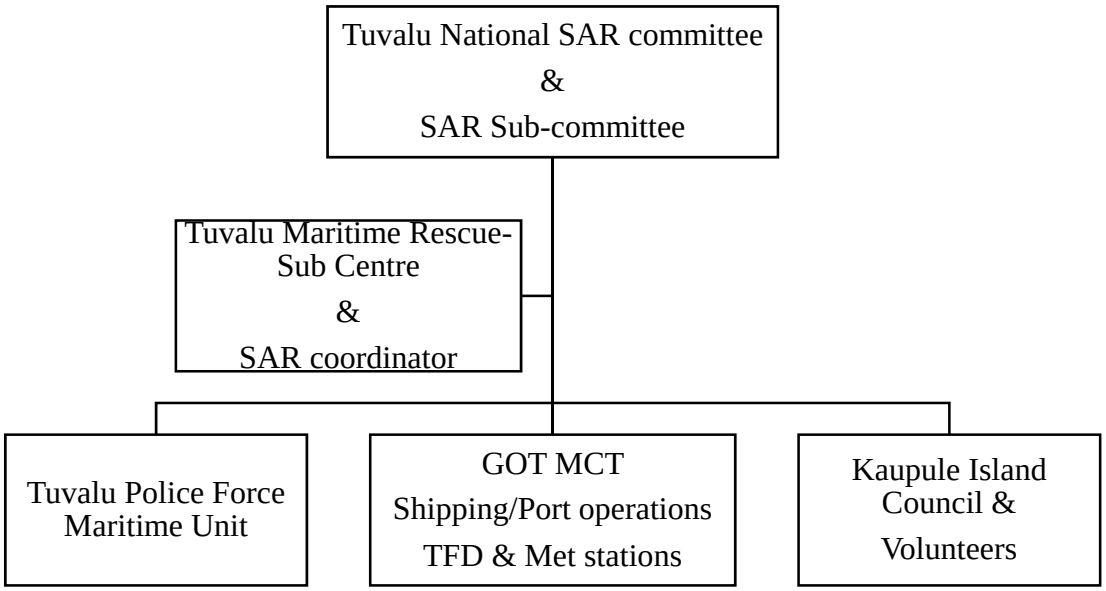
The complexity of the judiciary and legislature system in Tuvalu to codify international regulations to national legislations and formal acts stemming from government are based on cabinet decisions and approval by parliament members. It is of utmost importance that Tuvalu implement a national SAR legislation to provide legal basis for the establishment of SAR organization, policies, resources and procedures.

The GOT legislative provisions shall be aligned with accepted principles of national and international law affecting SAR activities such as sovereignty issues and claims for damages to the national government. The present legal situation shall be changed to fully support SAR and consideration given to the basic provisions of the SAR convention and related SAR instruments.

4.2 National SAR committee formation

The government of Tuvalu shall establish an act, decree or order to form a National SAR coordinating committee including organizations involved in SAR services and that they support them, ensuring that its authority, effectiveness, timelines and proficiency are securely established. The non-existent of a national SAR committee shall be brought to life incorporated with senior executives in the government ministries and officials with technical and maritime background. Figure 15 below illustrates the proposed Tuvalu national SAR committee organization structure.

Figure 15: Tuvalu National SAR committee organizational structure



Source: Authors own work

4.2.1 National SAR committee responsibilities

The committee shall include:

1. Secretary for Transport and Communication (Chairman);
2. Assistant Secretary for Transport and Communication (Deputy Chair);
3. Director of Marine and Port services;
4. Crown counsel;
5. Director of meteorological service;
6. Director of Civil Aviation;
7. Secretary of Home Affairs;
8. Secretary of Environment, Foreign Affairs, Labour and Trade;
9. Assistant Secretary of Envrionment, Foreign Affairs, Labour and Trade;
10. Director of Fisheries;
11. Tuvalu Police maritime unit Maritime Commander;
12. Tuvalu Police Force Commissioner;
13. Director of Disaster management;

14. Director of Tuvalu Telecommunication Corporation.

SAR Sub-committee:

The Tuvalu National SAR sub-committee are those responsible for coordinating and managing the MRSC with SAR coordinator and DMPS during SAR operations which includes any three or more of any of the following members within the government of Tuvalu:

- Director of Disaster management;
- Maritime Commander (Tuvalu Police Force maritime unit);
- Commissioner of Police;
- Assistant Secretary for Transport and Communication;
- Assistant Secretary for Environment, Foreign Affairs, Labour and Trade;
- Director of Civil Aviation;
- Director of Meteorological service;
- Director of Fisheries.

The National SAR committee are from the following departments:

- Ministry of Communication and Transport and Communication Marine and Port services;
- The office of the Attorney general;
- The weather and forecasting department;
- Civil Aviation and airport services;
- Ministry of Home Affairs;
- Ministry of Environment, Foreign affairs, Labour and Trade;
- Ministry of Fisheries;
- Tuvalu Police Force;
- Tuvalu Telecommunications Corporation.

The National SAR committee general responsibilities and objectives:

- To formulate and recommend a national strategic SAR policy for government approval;
- Shall meet on a quarterly basis to review and develop SAR services;
- To develop and maintain a National SAR manual;
- Plan funding and development of SAR operations;
- Training and development of SAR staff;
- Provide interface with regional and international organizations involved in SAR services;
- Improve collaboration between aeronautical and maritime SAR services;
- Develop plans for SAR resources and how they will be used effectively;
- Review Tuvalu National SAR organization structure and responsibilities;
- Notify Minister of Finance for financial policy of SAR operations;
- Propose funding from IMO technical fund for SAR development;
- To register Tuvalu as member of the International Maritime Rescue Federation to improve SAR services and provide capacity building;
- Organize and promote SAR exercise and training;
- Organize the engagement with PACSAR and SPC for SAR related matters capacity building and development of resources;
- Implement a Ship Reporting System for vessels entering and departing Tuvalu's EEZ;
- Establish a Maritime Search and Rescue-sub center and Helicopter rescue unit;
- To provide MRSC with GMDSS systems and required installations of SAR monitoring equipment;
- Establish technology innovations in SAR services to provide UAVs, Helicopter unit and improve mobile coverage network around the coast of Tuvalu for better reception;
- Establish GMDSS radio communication systems in all the Kaupule Island council around Tuvalu.

4.3 Proposal for a National SAR plan

A plan for SAR cooperation should be made up of six parts and information given therein can be divided into the following areas of company and ships information, SAR facilities, SAR information, media relations and periodic exercises. The SAR plan should be based on a framework of multilateral or bilateral negotiations and agreement with the neighboring state or states providing SAR services in adjacent seas and coastal waters to achieve co-operation and mutual support in responding to the distress incidents.

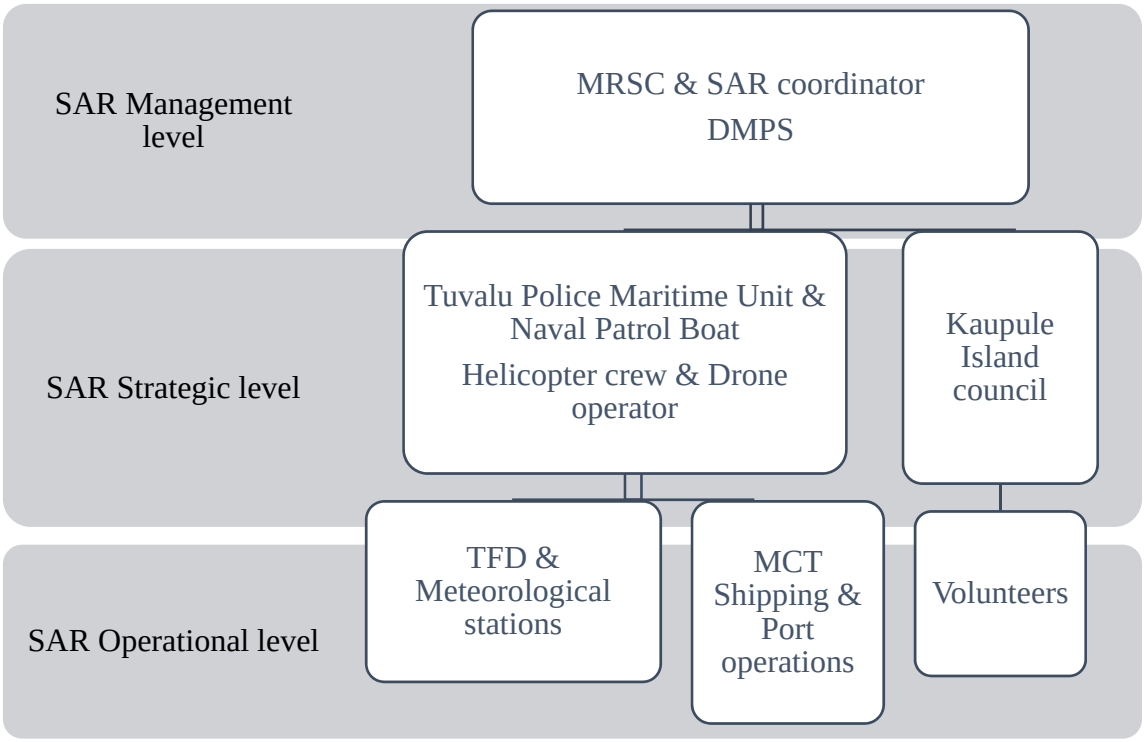
The Tuvalu National SAR plan should include search and rescue functions within Tuvalu's EEZ, Maritime Rescue-sub center, SAR support systems and all SAR organization participants. The requirement of IMO to adopt the SAR convention is to have a provisional plan. This set up form a framework and principles for Tuvalu National SAR plan which includes:

- description of Tuvalu SAR area includes EEZ;
- legal procedure to conduct SAR services and agreement with SRR for regional cooperation and sharing resources;
- provision of facilities, equipment and participants;
- implementation of GMDS and communication links;
- requirements of training and certification for all personnel within the SAR organization structure;
- coordination and collaboration of SAR personnel and resources within the SAR organization structure;
- procedure for aeronautical and maritime services for SAR response;
- provision of responsibilities for SAR participants.

For procedure and international requirements for SAR plan and SAR manual are available from IAMSAR Manual volume I, volume II and volume III to harmonize aeronautical and maritime communications.

4.4 National SAR organizational structure

Figure 16: Proposed General SAR Organizational structure



Source: Author´s own work

4.4.1 SAR organization description of responsibilities

Maritime Rescue Sub-center (MRSC)

The Maritime Rescue Sub-center (MRSC) is a subservient to an RCC dedicated exclusively to organizing search and rescue services within a prescribed SAR geographic area of SRR. MRSC based in Funafuti as the headquarter will coordinate and manage all SAR operations around Tuvalu. The GMDSS search area covered initially will be up to Sea area 2 and will increase to Sea area 3 while developing the MRSC. The Helicopter SAR services and UAVs operations will be established in the GOT marine department and integrated with MRSC for coordination of SAR.

Kaupule Island Council

SAR services on outer islands will be coordinated by the Kaupule Island Council under the direction of SAR Coordinator. GMDSS radio communication systems, satellite phones and Drones should be available for SAR response and volunteers on each island with use of available resources including boats for short range recovery of casualties.

SAR Coordinator

The duly appointed SAR Coordinator will be established within the government of Tuvalu marine department to coordinate SAR operations with the DMPS within the MRSC.

Director of Marine and Port Services (Deputy SAR Coordinator):

DMPS will act and assist SAR coordinator in the coordination of SAR operations and management of MRSC systems.

Helicopter crew and UAV operator:

The isolated islands in Tuvalu makes it difficult for SAR operations and medical evacuation of casualties by boats to Funafuti are high-cost budget for the government of Tuvalu. Helicopter and UAV operations for SAR and MEDIVAC will be an initiative that has not been recognized by the government of Tuvalu as the effective and most economical method for any SAR or MEDIVAC operations.

The duly appointed Drone operator will deploy drone searches for initial SAR response and the Helicopter service will only be employed for long-range SAR response and casualty retrieval from distress points.

Tuvalu Police Force Maritime Unit

The shore-based Maritime Commander and the Tuvalu Naval Patrol Boat Commanding Officer will oversee the ground operations of SAR and the optimal use of all available resources. All personnel and resources within the scope of SAR operational level will be monitored and coordinated by the Tuvalu Police Maritime Unit.

4.5 Proposal for MRSC and SAR support system

The Tuvalu Maritime Rescue-sub Center shall comprise of the following SAR systems and resources to meet IMO, ITU and ICAO requirements:

- VHF Radiotelephony (6);
- VHF DSC (4);
- MF DSC (2);
- MF/HF Radiotelephony (2);
- Satellite phones (2);
- UAV (Drones) (4);
- SAR helicopter.

UAV (Drone) for search and rescue

The SAR drone is an essential tool for rescuers not only they are easy to operate but also improves the efficiency of any operation reducing search times and overuse of resources. Drones have limitations on their cruise range and serve as the first response in an initial search. The government of Tuvalu should develop a framework and legislate the external use of drones.

Mobile telephone (Satellite and Cellular)

A satellite telephone connects to orbiting satellites and can provide regional or global coverage. All Kaupule council provided with satellite phones as an alternative when radio communication system fails during SAR operations.

Operational cost for Drone and Helicopter services

Figure 17: Analysis of SAR operation cost

	Cost of unit in USD	Operation cost per hour
Helicopter	$500,000.00	$250.00
Drone	$1800.00	2 hours of flight time at no cost
Patrol Boat	$226,000000.00	$600.00

Source: Author's own work

Comparison of SAR response system in Tuvalu

Figure 18: Analysis of SAR response and casualty retrieval

	Speed	Endurance	Time-to-locate casualty at 4 miles
Drone	44 knots	7 miles	3 minutes
Helicopter	140 knots	779 miles	1 minute
Patrol Boat	12 knots	3000 miles	24 minutes

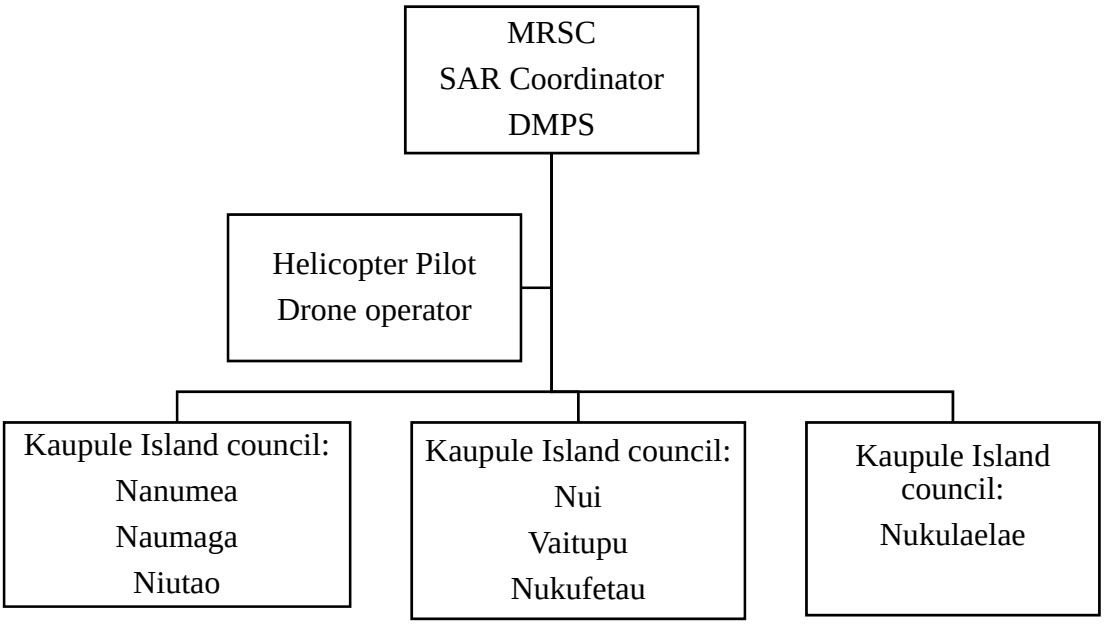
Source: Author's own work

The comparison in Figure 18 above based on technical factors determined the most reliable SAR response system according to efficiency and cost effectiveness will be:

1. Drone for initial search;
2. Helicopter for retrieval of casualties.

4.6 Proposal for SAR development on outer islands

Figure 19: Proposed Tuvalu SAR operation structure



Source: Authors own work

SAR operations structure includes all Kaupule council as SAR coordinators on all the islands, GMDSS communication system and UAVs will be established on all the islands for improvement of SAR response and coordination. SAR resources includes:

- VHF RT/DSC (2);
- MF DSC (2);
- MF/HF RT (2);
- UAVs (2);
- Satellite phone (1).

The author recommended communication procedures between Kaupule council, Aircrew and the head of SAR service at MRSC to follow GMDSS guidelines provided in previous chapters.

4.7 Plan for SAR exercises

Exercises improve and test operational plans, improve liaison and provide learning experience and coordination skills. The purpose of conducting SAR exercises on a realistic basis:

- demonstrates the true effectiveness of training;
- assess the operational efficiency and competence of the SAR service;
- reveal deficiencies in SAR plans;
- will be critical in sustaining proficiency.

There are three levels of conducting exercises in Tuvalu SAR organization, it should be based on:

1. Communication exercise consist of periodic use of all available means of communication between all parties to ensure capability for actual emergencies;
2. Coordination exercise involves simulated response to a crisis based on a series of scenarios;
3. Full-scale exercise involves actual SAR facilities deployed.

To measure success of an exercise requires to know:

- How many problems are discovered;
- How much is learned;
- How much operating plans are improved; and
- How few mistakes are repeated during the next exercises.

References regarding requirements for conduct of SAR exercises between aircraft and vessels are available in SOLAS and IAMSAR manual for aeronautical and maritime services.

4.8 Training and certification

The provision of training for search and rescue involves theoretical and practical aspects of coordinating SAR operations and should be available for building capacity of SAR Coordinators, Aircrew, Drone operators, MRSC staff and Kaupule Council within the organization structure. The purpose of certification is the process of providing recognition as an official document attesting a level of achievement. According to IAMSAR manual the program should comprise of the following:

- Provision of training based on SAR techniques, procedures and equipment through course materials, multimedia, etc;
- Observing actual operations; and
- Exercises in simulated operation to coordinate individual procedures and techniques.

The SAR Coordinator will be responsible for facilitating adequate training programs and ensuring that all SAR personnel maintain and reach a high level of competency, to reduce risks to facilities and personnel and to achieve objectives of the organization to rescue casualties at sea in a more effective manner. There are No SAR training in Tuvalu. The author suggests for training and certification program of the Australian Maritime Safety Authority for search and rescue organization will be based on four areas:

1. SAR operators;

2. GMDSS operators;

3. Helicopter Pilots;

4. Drones operators.

The details of the courses and outline of programs at the Australian Maritime College and SAR training Australia are as follows:

1.Search and rescue operators

- Introduction to search and rescue (10 weeks);
- Search and rescue coordination (2 weeks);
- COSPAS-SARSAT and MEOSAR (1 week);
- Remote Area Search and Rescue (2 weeks).

2.GMDSS operators

GMDSS General Operators Certificate Course (AMSA approved), meeting the requirements of STCW Regulation IV/2 and Code Section A-IV/2 and in accordance with Marine Order 6 (Marine Radio Qualifications) 2000 (10 days).

3.Helicopter Aircrew

- Aviation fuel quality control;
- Air search observer training;
- Introductory crewman course;
- Certificate III in Aviation;
- Certificate IV in Aviation;
- Emergency Breathing Systems;
- Helicopter and Aircraft Refueling;
- Helicopter Landing Officer;
- Night Vision Goggle Training;
- Pilot training.

4.Drones operator

Remote Pilot's License (2 weeks).
This course is accredited by the Civil Aviation Authority of Australia conducted online and involves practical training. There are 14 modules in the syllabus:

Module 1: General introduction and overview of the course
Module 2: Airspace, charts and other aeronautical publications (theory training)
Module 3: Basic aviation knowledge for RPA (theory training)
Module 4: Electrical and electronic systems for RPA (theory training)
Module 5: Meteorology for RPA (theory training)
Module 6: Human performance for RPA (theory training)
Module 7: RPA knowledge of operations and procedures (theory training)
Module 8: Operation rules and rules of the air for RPA (theory training)
Module 9: Pre and post operation actions and procedures for RPA
Module 10: Energy management for RPA
Module 11: Manage other persons in relation to RPA operation
Module 12: Navigation for RPA operations
Module 13: Non-technical skills for operation of RPA
Module 14: RPA that is multirotor

(Source: AMC, n.d)

4.9 Conclusion

As a signatory to SOLAS convention Tuvalu is bound to provide maritime search and rescue as well as facilitating inter-agency cooperation and coordination. Based on discussions and analyses on previous chapters, the government of Tuvalu SAR area should continue to remain in Fiji SRR while adopting the International convention on maritime search and rescue. This will improve SAR services within Tuvalu waters, provide assistance to neighboring countries and strengthen Fiji SRR capabilities to enhance maritime safety.

The operation, design and manning of small craft in Tuvalu requires stringent guidelines and regulations to improve standards of safety as to reduce the number of incidents in Tuvalu waters. The government of Tuvalu have to seek funding through IMO technical fund for SAR and capacity building programs provided by IMRF, PACSAR and SPC to improve the provision of SAR in Tuvalu. The MRSC is responsible for coordinating, planning and execution of SAR operations. SAR operations cannot be successfully carried out without efficient communication and collaboration between participants. The development of Tuvalu maritime SAR organization should focus in the following areas:

1. Legislation be enacted to give Tuvalu MRSC a high level of authority pertaining to maritime SAR to control and command SAR resources, in times of emergency within government and non-government agencies;
2. Supporting and developing initiatives aimed at minimizing risk to SAR personnel, reducing search time and improving rescue effectiveness:
3. To conduct regular SAR exercises, communication checks and sharing of SAR resources with neighboring SRR which may include: techniques, information, procedures, personnel, facilities and equipment;
4. To develop the national master plan including all available units including aircraft, boats and equipment to be well documented and available for emergency use, guidelines according to IMO are provided in Appendix 2;
5. To minimize loss of life and reduce rate of incidents by implementing SAR prevention program focused on common SAR incidents;
6. The provision of training and capacity building programs to ensure that SAR personnel have a high level of competency to obtain an international acceptable standard;
7. To consult with IMO, PACSAR, SPC for technical assistance, attend workshop meetings and seminars to improve SAR operations at national and regional level;
8. Based on research more than 90% of government staff in the Tuvalu maritime administration had agreed for Tuvalu to adopt the SAR convention and develop maritime search and rescue in Tuvalu.

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Appendix 1

MARITIME SEARCH AND RESCUE QUESTIONNAIRE

Name and Title	
Organization	
Address	

Part A: Maritime Search and Rescue improvement in Tuvalu

1. Do you agree or disagree that Tuvalu should ratify the IMO Maritime Search and Rescue Convention?

2. Briefly explain why you think Tuvalu should or should not ratify the Maritime SAR convention?

3. Which government agencies have the authority and responsibility for coordination of maritime SAR? Where is this authority and responsibility described?

PART B: SAR resources

4. What are the primary SAR resources which you rely on while carrying out SAR operations?

5. Do you have special equipment or methods which are utilized to respond during a night search? Brief describe briefly if applicable.

6. Does your State have a national SAR Plan which describes the roles of all government and non-government organizations which have resources that can support SAR?

7. Does your State have formal SAR agreements for inter-agency coordination and cooperation with neighboring countries?

8. Are the National SAR response personnel assigned to perform other tasks which might detract them from their ability to handle their primary SAR responsibilities?

9. Please describe your RCC's organizational structure as well as its main functions.

Part C: SAR Data

Please provide your past 10 years' SAR data according to the following form:

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cases										
Responses										
Live saved										
Live lost before notification										
Live lost after notification										
Persons otherwise assisted										

6. Please describe 2-3 typical SAR cases, which you might respond to in an average month.

Part D: SAR Training

Has your SAR staff been trained to do the following?	**Yes**	**No**
Recognize the stages and phases of a SAR mission		
Determine search datum, search areas, and probability of success		
Account for ocean drift		
Develop search action plans and rescue action plans		
Allocate resources		
Carry out international SAR obligations		
Do your RCCs regularly work with other RCCs outside your region		
Is there a formal planning and evaluation process for these exercises		
Have all of your national SAR personnel attended formal SAR training		

PART E: Recommendations

Please provide your recommendations or any feedback on how Tuvalu could further develop its maritime search and rescue mission.

APPENDIX 2

INTERNATIONAL MARITIME ORGANIZATION

E

4 ALBERT EMBANKMENT
LONDON SE1 7SR
Telephone: +44 (0)20 7735 7611 Fax: +44 (0)20 7587 3210

GMDSS.1/Circ.23
4 March 2019

MASTER PLAN OF SHORE-BASED FACILITIES FOR THE GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (GMDSS MASTER PLAN)

1 The Sub-Committee on Navigation, Communications and Search and Rescue (NCSR), at its third session (29 February to 4 March 2016), agreed to the development of a new module of the Global Integrated Shipping Information System (GISIS) to facilitate the communication of information to the Organization on shore-based facilities for the Global Maritime Distress and Safety System (GMDSS), as required under SOLAS regulation IV/5. The Maritime Safety Committee (MSC), at its ninety-seventh session (21 to 25 November 2016), endorsed the development of the new GISIS module to replace the existing GMDSS.1 circulars on the Master plan of shore-based facilities for the GMDSS (GMDSS Master Plan).

2 The NCSR Sub-Committee, at its sixth session (16 to 25 January 2019), noted that the new GISIS module on the GMDSS Master Plan had been completed, including the migration process of the information contained in the annexes of GMDSS.1/Circ.22, and invited Member States to verify the accuracy of the information migrated into the new GISIS module and to update the information before the content was released to all registered Public Account holders.[1]

3 As from 28 February 2019, all information related to shore-based facilities for the GMDSS communicated to the Organization is available to all registered Public Account holders through the new GISIS module on the GMDSS Master Plan.

4 The information contained in the GMDSS Master Plan GISIS module is similarly structured as the GMDSS Master Plan in previous GMDSS.1 circulars (annexes 1 to 12). The module is divided into 12 sections, as follows:

.1 Status of facilities;[2]

.2 Sea Area A1 (within range of shore-based VHF DSC coverage);

.3 Sea Area A2 (within range of shore-based MF DSC coverage);

.4 Sea Areas A3 and A4 (outside sea area A2);

.5 Inmarsat facilities;

.6 Coordination Centres (RCCs) using Inmarsat Ship Earth Stations (SESs);

.7 NAVTEX Service;[3]

.8 International SafetyNET Service;[3]

.9 HF Narrow Band Direct Printing (NBDP) MSI Broadcast Service;

.10 Cospas-Sarsat MCC and LUT;

.11 EPIRB Registration Data; and

.12 Contact Points for Global Maritime Distress and Safety System (GMDSS).[4]

5 Additional functionalities to download or export the information contained in different sections are currently under development and will be available in due course.

6 Member States are invited to review and update the information direcly in the new GISIS module, as and when changes occur. In accordance with Circular Letter No.2892, nominated IMO Web Accounts administrators of Member States can authorize users within their Administration as GMDSS module managers who will be the only person(s) authorized to make changes, update and submit information, after 28 February 2019.

7 Member States are also invited to bring the information in this circular to the attention of all parties concerned.

8 This circular supersedes GMDSS.1/Circ.22 issued on 30 July 2018.