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INTERAFRICAN BUREAU
FOR ANIMAL RESOURCES

REGIONAL FRAMEWORK ON ENVIRONMENTAL MANAGEMENT FOR SUSTAINABLE AQUACULTURE DEVELOPMENT IN AFRICA -

Southern Africa Region

Prepared by: Etienne Hinrichsen, AquaEco, PO Box 76245, Lynnwood Ridge, 0040, South Africa.

Edited by: Dr. Nelly Isyagi, Dr. Motseki Hlatshwayo, Dr. Mohamed Seisay and Dr. Simplice Nouala

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Requests for such permission should be addressed to:
The Director
African Union – Interafrican Bureau for Animal Resources (AU-IBAR)
Kenindia Business Park
Museum Hill, Westlands Road
P.O. Box 30786
00100, Nairobi, KENYA
Or by e-mail to: ibar.office@au-ibar.org

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ACRONYMS AND ABBREVIATIONS

AU-IBAR	African Union - Inter-African Bureau for Animal Resources
e.g.	exempli gratia - for example
EIA	Environmental Impact Assessment
EMP	Environmental Management Programme
etc.	et cetera - and so forth
FAO	Food and Agricultural Organisation
GIS	Geographic Information System
HACCP	Hazard Analysis Critical Control Point
ISO	International Organization for Standardisation
NEPAD	New Partnership for Africa's Development
OIE	Office International des Epizooties / World Organisation for Animal Health
PO	Post Office
REC	Regional Economic Community
$	United States Dollar
SADC	Southern African Development Community
SEA	Strategic Environmental Assessment
UN	United Nations
US	United States

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FORWARD

Aquatic ecosystems provide several goods and services including for fisheries and aquaculture production. Aquatic ecosystems are also the ultimate recipients of pollution from human activity, including from aquatic production practices. The productivity of aquatic production systems, aquaculture not withstanding depends on the status of aquatic resources. Aquatic resources are generally considered renewable. However, even while this might be so, they are not infinite. They need to be properly managed if their contribution to nutrition, economic and social well-being of the growing world's population is to be sustained. Irresponsible aquatic production practices can have significant adverse environmental and social impacts.

Africa's continental fisheries and development strategy, The Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (PFRS) consequently advocates for the sustainable management of aquatic resources for sustainable fisheries and aquaculture development. The FAO Code of Conduct for Responsible Fisheries encompasses this approach. The paradigm of this is enshrined in the Ecosystem Approach to Aquaculture. The ecosystem approach to aquaculture (EAA) is a strategy for the integration of aquaculture within the wider ecosystem to ensure sustainable development, equity and resilience of interlinked social-ecological systems.

In line with these, several African Member States require Environmental Impact Assessments as part of the requirements for the approval of large commercial aquaculture projects. However, it is the Continent's overall objective to expand commercial aquaculture to the level whereby aquaculture becomes a major contributor to fish production, rural employment, income as well as food and nutrition security. This infers that the number and size of operations as well as technologies employed shall increase and become more diversified.

Sustainable aquaculture development at such a scale entails that the application of strategic sectoral environment management approaches that do not just focus at the farm but also factor in the wider environment. This is because in practice, aquaculture is dependent upon the entire ecosystem. For example, at geographical level, clusters of farms that share a common waterbody or watershed need coordinated management to ensure sustainable utilisation and biosecurity. Cultured species are sensitive to water quality and are therefore extremely vulnerable to the damage inflicted by other users of the waterbody or watershed. Furthermore, while disease incidences can be controlled at farm level, their effects occur at the watershed level and often do require control, management and mitigation at the watershed level. Likewise, exotic fish that escape from fish farms often impacts on biodiversity across the entire watershed. External drivers of aquaculture such as population growth and development, trade and climate change also affect entire ecosystem. Watershed boundaries, trade and climate change transcend national boundaries.

Sustainable aquaculture development founded on the principles of EAA therefore requires transboundary initiatives. Common, coherent and practical regional frameworks and policies that promote sustainable development and responsible practice of aquaculture within watershed resource limits are inevitable necessary if the Continent's sustainable commercial aquaculture development goals are to be achieved. Given the importance, this Regional Framework was thus developed as a result of a consultative process that involved a **Consultative Regional Workshops on Aquaculture Environmental Management** to draft the framework that drew participants from the public and private sector involved in producers and other sector actors, environmental management agencies and aquaculture managers. The draft was circulated to Member States for review prior to validation by the **35th Meeting of the SADC Technical Committee on Fisheries**.

Having frameworks for Environmental Management for Sustainable Aquaculture Development shall strengthen the capacity of Member States to make more realistic and appropriate aquaculture development plans, approve appropriate projects and institute environmental management assessments more effectively.

Additionally the adoption and mainstreaming of the Regional Frameworks into National Aquaculture Development Plans and Strategies shall facilitate the development and implementation of BMPs for all stakeholders, lower costs for undertaking Environmental Impact Assessments for practitioners, make it easier to implement labelling and certification of products and zone areas for aquaculture.

Prof. Ahmed El-Sawalhy
Director, AU-IBAR

PREAMBLE

The development of this Regional Framework on Environmental Management for Sustainable Aquaculture Development in Africa - Southern African Region, has been commissioned by the African Union: Interafrican Bureau for Animal Resources (AU-IBAR). It has been developed as a support tool to the strategic objectives contained in the Southern African Development Community's (SADC) Regional Aquaculture Strategy and Action Plan (2016 - 2026). It provides a framework to facilitate the implementation of a range of international and regional environmental strategies and guidelines, together with locally developed tools, in a regionally cooperative manner that is specific to the nature and character of Southern African aquaculture.

A Regional Consultative Workshop on Environmental Management in Aquaculture (Maputo, February 2016), provided the baseline inputs from various SADC Member States. These baseline inputs in environmental and social aspects related to regional aquaculture were captured and combined with reference materials from various international and regional frameworks and guidelines in the formulation of this document.

This framework does not intend to replace or to be in conflict with any sovereign policy, strategy or statutory provisions related to aquaculture in any particular country. On the contrary, this framework seeks specifically to support such sovereign texts. This framework is pursuant to providing support to SADC Member States in the adoption and implementation of Section 2 in Article 13 of the SADC Protocol on Fisheries (2001), which reads "State Parties shall review policies, legislation, plans and institutions to address the characteristics and needs of aquaculture in recognition of the fact that aquaculture is a distinct enterprise".

EXECUTIVE SUMMARY

The development of this Regional Framework on Environmental Management for Sustainable Aquaculture Development in Africa - Southern African Region, has been commissioned by the African Union: Interafrican Bureau for Animal Resources (AU-IBAR). It has been developed as a support tool to the strategic objectives contained in the Southern African Development Community's (SADC) Regional Aquaculture Strategy and Action Plan (2016 - 2026). It provides a framework to facilitate the implementation of a range of international and regional environmental strategies and guidelines, together with locally developed tools, in a regionally cooperative manner that is specific to the nature and character of Southern African aquaculture.

This framework seeks to provide an outline to sustainable aquaculture development and operation in the Southern African region; given the unique character of this region in terms of resources, opportunities, challenges, people and other factors. The framework has been designed to provide a simple, yet clear pathway for the development and operation of aquaculture as an integrated component of the natural and human landscapes of the Southern African region.

The framework consists of five pillars or focal areas:

i. The first involves the contextualisation of aquaculture in the region and the alignment of the framework with existing polices, regional and international frameworks, strategies, protocols and guidelines.
ii. The second involves the identification of key environmental challenges that affect sector sustainability, and the establishment of broad interventions to address these.
iii. The third involves that identification of key socio-economic challenges that affect sector sustainability, and the establishment of broad interventions to address these.
iv. The fourth pillar contains the planning and environmental management tools that can be used regionally to improve the development of a sustainable sector.
v. The fifth pillar contains the institutional arrangements for implementation of the framework.

Under the contextualization of aquaculture in the region (first pillar) the framework identifies the users of the document, and positions it in terms of established policy directions for that have been established by the SADC and the AU-IBAR. Concurrently, the framework contextualizes the character of aquaculture in the Southern African region and identifies the key challenges and opportunities in the sector.

The pillar related to the identification of key environmental challenges deals with matters such as sustainable access and use of natural resources for aquaculture, including water and land. Within the interventions that are recommended, the issue of resource user conflict is addressed, as well as the effects that a changing environment (e.g. in terms of climate change and pollution from other human activities) can have on aquaculture. The environmental challenges related to aquaculture are further identified in matters such as the sustainable sourcing and use of feeds, the responsible use of exotic and genetically diffident species, as well as the impacts of health and disease. These potential impacts are also considered for their respective effects on product safety and consumer health.

The pillar related to socio-economic matters also deals with resource access and how better to develop aquaculture through zoning and clustering, where this is appropriate. The importance of information, knowhow, skills and the empowerment of people is emphasized through a number of sections that deal with aspects such as research and technology development, access to knowledge, development of human resources and enhancement of sector participation through smallholder and commercial linkages. The creation of a conducive and safe working environment is discussed as a prerequisite to a socially responsive

sector, while the development of the market is identified as the core area that will facilitate greater socio-economic beneficiation from the aquaculture sector.

The tools (fourth pillar) that can be used regionally to improve the development and management of a sustainable sector include spatial planning, project planning through environmental and strategic impact assessment within the ecosystem approach, impact mitigation and sector monitoring. Increasingly, the need for the implementation of sector standards and best management practices is becoming an imperative to compete in the formal and global markets for aquaculture products. Although these may not be essential to the development of small scale or rural aquaculture, the sector as a whole will benefit from improvements therein.

The institutional arrangements (fifth pillar) for implementation of this framework involves the establishment and maintenance of a central information platform or hub for improved regional dissemination of information and collective or cooperative implementation of the framework principles and interventions. In this regard, the establishment of an aquaculture development focal point in each SADC Member State has been recommended, while the platform or hub can be centrally coordinated by the SADC or AU-IBAR.

1. INTRODUCTION

The development of this Regional Framework on Environmental Management for Sustainable Aquaculture Development in Africa - Southern African Region, has been commissioned by the African Union: Interafrican Bureau for Animal Resources (AU-IBAR). It has been developed as a support tool to the strategic objectives contained in the Southern African Development Community's (SADC) Regional Aquaculture Strategy and Action Plan (2016 - 2026). It provides a framework to facilitate the implementation of a range of international and regional environmental strategies and guidelines, together with locally developed tools, in a regionally cooperative manner that is specific to the nature and character of Southern African aquaculture.

This first chapter positions the framework in terms of its purpose, objectives and principles, while defining its users and its structure in relation to relevant policies, international and regional environmental strategies and guidelines.

1.1. PURPOSE AND OBJECTIVES

This framework seeks to provide an outline to sustainable aquaculture development and operation in the Southern African region; given the unique character of this region in terms of resources, opportunities, challenges, people and other factors. The framework has been designed to provide a simple, yet clear pathway for the development and operation of aquaculture as an integrated component of the natural and human landscapes of the Southern African region.

Grounded within the SADC Vision of a Common Future, a future within a regional community that will ensure economic well-being, improvement of the standards of living and quality of life, freedom and social justice and peace and security for the people of Southern Africa, this aquaculture framework's objectives are:

i. To clearly position sustainable aquaculture as an essential and core human endeavour in the regional landscape.
ii. To provide a better understanding of what defines sustainable aquaculture.
iii. To assist in empowering SADC Member States, aquaculture operators, communities and individuals in applying sustainable aquaculture principles and adopting these into local policy, strategy, law, guidelines, business and operational models.
iv. To identify and promote awareness of the potential positive and negative impacts associated with aquaculture.
v. To present an approach to better pursue sustainable aquaculture development goals.
vi. To provide a balanced and encompassing overview of the potential environmental and social impacts of aquaculture, and the manner in which these aspects affect the greater regional aspirations of economic growth, the alleviate poverty and the enhancement of standards and qualities of lives.
vii. To create a common and mutually supportive approach to sustainable aquaculture in the region.

The promotion of the sustainable utilisation of natural resources and the effective protection of the environment, as echoed in the broader objectives of the SADC, are firmly entrenched in this framework.

1.2. OVERARCHING PRINCIPLES

This framework has been developed around, and subscribes to a number of core principles, which include, but are not limited to:

i. Participation of all the SADC Member States and all stakeholders that are involved in regional aquaculture. Participation includes meaningful, timely and representative engagement to arrive at

effective and informed decision-making around this framework, as well as the adoption and updating thereof.

ii. Equitability, in that the framework is just and dedicated to reason, conscience and a sense of what is fair, between people and Member States, but also between people and the environment.

iii. Transparency, in that the framework is a representation of the collective inputs from the SADC Member States and aquaculture stakeholders in the region, and in that it portrays the concept of environmental management for sustainable aquaculture development in an open and free manner, to the benefit of all.

iv. Accuracy, in that the framework seeks to portray exact and true information in a manner that is relevant to the nature of aquaculture in the region.

v. Sustainability, in that the framework subscribes to the meeting of resource and service needs of current and future generations, without compromising the health of the ecosystems that provide them. More specifically, the framework seeks to contribute to a state of balance, resilience and interconnectedness that allows human society to satisfy its needs, while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs, nor through our actions diminish resources and diversity (Morelli, 2011).

1.3. STRUCTURE OF THE FRAMEWORK

This framework document is divided into six distinct chapters that each deal with a specific area of importance:

Chapter 1: The introductory section positions the framework in terms of its purpose, objectives and principles, while defining its users and its structure in relation to relevant policies, international and regional environmental strategies and guidelines.

Chapter 2: This section provides a perspective to the regional aquaculture sector, defines aquaculture in general, differentiates between aquaculture types, identifies regional opportunities and challenges and talks to the adoption of the ecosystem approach to sustainable aquaculture.

Chapter 3: The third chapter identifies, groups and discusses the environmental aspects that are relevant to aquaculture in the region, with direction around the preferred approach to these aspects.

Chapter 4: The fourth chapter identifies, groups and discusses the socio-economic aspects that are relevant to aquaculture in the region, with guidance around the preferred approach h to these aspects.

Chapter 5: This section identifies the tools that can be applied in aquaculture development and operation, towards seeking greater sustainability and towards meeting the objectives of this framework.

Chapter 6: Chapter six contains the institutional arrangements related to regional adoption and implementation of this framework.

1.4. USERS OF THE FRAMEWORK

It is intended that this framework be adopted and implemented by all stakeholders associated with the aquaculture sector in the Southern African region. The primary stakeholders are identified as follows:

i. SADC Member States

This framework serves threefold as a record of the approach to sustainable aquaculture development and operation in the SADC region, as an aid to sovereign aquaculture management, policy, strategy and legal frameworks, and as a reference work for each Member State, which will assist with sustainable

domestic and regional aquaculture development and operation.

ii. Sector Participants

This framework seeks to assist current participants and new entrants into the aquaculture sector, to establish environmental and social management practices that will ensure an environmentally responsible, socially acceptable and sustainable sector. Sector participants include farmers, processors, distributors, technology and service providers, feed suppliers, sellers and other upstream and downstream stakeholders in the broadest possible context, and encompasses the range from small scale rural fish farmers to large corporate and industrialised aquaculture businesses. For all of these sector participants, this framework should serve as a procedural reference.

iii. Consumers

The entire aquaculture value chain depends on the consumers of aquaculture products. Although consumers are increasingly demanding insight to performance measures that prove sector sustainability, each consumer has an inherent (silent) right to aquaculture products that do not diminish the sustainability of the environment that each world citizen depends on. With this key role of the consumer in mind, it is envisaged that this framework will be invaluable in upholding consumer rights and in reinforcing the underlying values of sustainability in the regional aquaculture sector. Local, regional and international consumers may ultimately use this framework as a yardstick for sector performance.

iv. The Broader Public

Regardless of whether a person participates in, or consumes products from aquaculture, the sector has the potential to affect all people, either directly or indirectly, through joint resource utilisation, common economic effects and other societal prerogatives. Consequently, all people have an interest in sustainable aquaculture as advocated by this framework.

1.5. ALIGNMENT OF THE FRAMEWORK

Outside of existing country specific guideline and governing frameworks for aquaculture, a number of regional and international frameworks have a direct influence in the Southern African region. These respective frameworks, all of which have a distinct role in the sector, have been considered in the development of this region specific document. In this regard, the following regional and international frameworks are specifically referenced and have been considered, where appropriate:

i. The SADC as the Regional Economic Community (REC) in Southern Africa seeks development, economic growth and the alleviation of poverty (amongst other objectives), through regional integration and sustainable development.

   Pursuant to this, it has developed various regional protocols, including the SADC Protocol on Fisheries (2001), which plays a central role in that its Article 13 deals specifically with aquaculture and the obligations of Member States to develop and manage aquaculture in a responsible and sustainable manner. A number of other SADC policies, strategies and guidelines also support sustainable aquaculture practices, examples of which are:

   a. The SADC Declaration on Poverty Eradication and Sustainable Development (2008).
   b. The SADC Environment Mainstreaming Manual (2010).
   c. The SADC Guidelines for Strengthening River Basin Organisations (2010).
   d. SADC Policy Paper on Climate Change (2012).
   e. The SADC Regional Agricultural Policy (2013).
   f. The SADC Regional Aquatic Biosecurity Strategy (2015).
   g. The SADC Food and Nutrition Security Strategy (2015).

h. The SADC Regional Aquaculture Strategy and Action Plan (2016).

ii. The AU-IBAR provides leadership in the development of animal resources for Africa and its Regional Economic Communities such as SADC. The AU-IBAR's vision is that of an Africa free from hunger and poverty, in which animal resources such as aquaculture, make a significant contribution. This framework, commissioned by the AU-IBAR, is preceded by policies and guidelines for aquaculture, which include:
   a. The AU-IBAR Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (2014).
   b. The AU-IBAR Guide for the Implementation of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (2015).

iii. The New Partnership for African Development (NEPAD) plays a pivotal role in continental dialog related to the enhancement and development of sustainable aquaculture. NEPAD's Action Plan for the Development of African Fisheries and Aquaculture (2005) sets the African agenda for aquaculture development, which creates a leading framework for individual African countries and for many international organisations working in aquaculture on the African continent.

iv. Internationally, the Food and Agricultural Organisation (FAO) of the United Nations (UN), plays a vital role in the dissemination of information to enhance sustainable aquaculture development and to support the aquaculture sector in areas such as technology, operation and governance. The landmark Code of Conduct for Responsible Fisheries (1995), specifically addresses aquaculture development in Article 9, which deals with responsible aquaculture development under national jurisdiction, transboundary development matters, the use of aquatic genetic resources and responsible aquaculture practices at production level. The FAO has published a wealth of materials to support sustainable aquaculture, some of which is specific to the African continent and which is implemented by the Committee for Inland Fisheries and Aquaculture of Africa. Important examples of materials developed by the FAO include:
   a. Workshop on Developing Aquaculture as a Business within an Ecosystem Approach to the Sector (a NEPAD-FAO Fish Programme Report, 2015).
   b. Climate Change Adaptation in Fisheries and Aquaculture (2014).
   c. Sustainable Fisheries and Aquaculture for Food Security and Nutrition (2014).
   d. Site Selection and Carrying Capacities for Inland and Coastal Aquaculture (2013).
   e. Enhancing the Contribution of Small-scale Aquaculture to Food Security, Poverty Alleviation and Socio-economic Development (2013).
   f. Aquaculture Development: Ecosystem Approach to Aquaculture (2010).
   g. Aquaculture Planning: Policy Formulation and Implementation for Sustainable Development (2010).
   h. Practical Implementation of the Ecosystem Approach to Fisheries and Aquaculture (2009).
   i. Environmental Impact Assessment and Monitoring in Aquaculture (2009).
   j. Ecosystem Approach to Fisheries and Aquaculture: Implementing the FAO Code of Conduct for Responsible Fisheries (2009).
   k. Guiding Principles for Promoting Aquaculture in Africa - Benchmarks for Sustainable Development (2006).

v. Other organisations, international policies and frameworks also play an important role in Southern African aquaculture. These include (but are not limited to) the World Organisation for Animal Health (OIE - Office International des Epizooties), which oversees the Aquatic Animal Health Code (2016) and the Manual of Diagnostic Test for Aquatic Animals (2015). WorldFish, which is active in African aquaculture, is an international, non-profit research organization, seeking to harness the potential of sustainable fisheries and aquaculture to increase food and nutrition security and to promote better livelihoods.

2. REGIONAL PERSPECTIVE

2.1. DEFINING AQUACULTURE

Aquaculture is defined as the propagation, improvement, trade or rearing of aquatic organisms (plant and animal) in controlled or selected aquatic environments (fresh, sea or brackish waters) for any commercial, subsistence, recreational or other public or private purpose.

Due to the fact that aquaculture encompasses all farming practices in a water medium, a wide range of aquaculture types and techniques exist. Likewise, many different means of classification of these aquaculture types exist, including classification by species, scale, environment, water use and more. Classification by production system is often used as a broad or general means by which aquaculture types are distinguished. In this regard, aquaculture can be roughly divided into cage culture, tank culture (including raceway culture) and pond culture.

Cage culture refers to the use of net pens, while tank culture makes use of many different tank sizes, shapes, configurations and construction materials that range from plastics to concrete and glass. Pond culture mostly refers to earthen ponds, but includes the use of pond linings of various materials.

Classification of aquaculture by the intensity of production refers to extensive production as opposed to semi-intensive and intensive production, where the level of technology, capital expenditure, running cost, control, risk and volume of production per unit area typically increases from the less to the more intensive practices. Associated, but not necessarily linked to this, is the magnitude or scale of production that can be broadly divided into small-scale operations (often subsistence ventures), medium scale enterprises and large-scale enterprises (also referred to as industrial aquaculture).

Further classification is possible according to the nature of water use. In this regard differentiation can be made between closed systems where no (or very little) water is replaced, semi-open systems where water is supplemented or replaced from time to time and flow-through or open systems where new water is continuously replacing water in the production system. In most cases, the water entering into open or semi-open systems allows for the replenishment of oxygen and the removal of production wastes. In closed systems, oxygen (if required) must be added by other means, while production wastes are generally removed by continuous re-circulation and water filtration.

Categorisation by species can be varied and includes typical species groups [e.g. finfish, shellfish (including crustaceans and molluscs), aquatic plants or algae] to typical user groups (e.g. ornamental use or fish for use as food).

It goes without saying that the availability of water as a farming medium is essential. Nevertheless, the quantity and quality of water that is required is directly related to the type of farming system, the target species, the farming method and the manner in which water is applied, cleaned and re-used.

In many modern aquaculture systems, the aim is to increase and optimize farming densities (resulting in the need for less water), while retaining and cleaning water for re-use, or for integration with associated agricultural practices such as crop irrigation.

Examples of cage culture systems that range from small basic structures to large and technologically advanced production systems.

Examples of tank culture systems that range from outdoor circular tanks to technologically advanced indoor systems of various shapes and sizes.

Examples of pond culture systems that most often consist of earthen ponds of various sizes and shapes.

Figure 1: *Examples of aquaculture systems.*

Aquaculture is rapidly becoming a sector with the potential to contribute to the diversification of the agricultural economy; but also to create skills, broaden economic participation, reduce poverty, enhance food security and increase employment and business opportunities. Some of the underlying driving forces of rapid global aquaculture development include:

i. Fish farmed in aquaculture, convert animal feed resources (protein) more efficiently than traditionally farmed terrestrial animals, mainly due to the fact that they are cold blooded and therefor do not waste energy for body temperature regulation.
ii. Fish can be farmed in water in an integrated manner, meaning that the water is not wasted and can be applied for other uses such as traditional crop irrigation.
iii. The spatial requirements for aquaculture is small, meaning that vast tracts of land (such as for crop farming) is generally not necessary.
iv. Fish products are in demand and have been shown to be a healthier alternative.

2.2. OVERVIEW OF AQUACULTURE IN THE REGION

By 2030, says the World Bank (2013), fish farming will dominate global fish supplies, and it is now well known that marine harvesting and terrestrial rangeland farming has reached its capacity in many parts of the world. Aquaculture and intensified agriculture remains the only alternative to supplying a growing food need, fuelled by an increasing global population. Increasing food prices, the increasing demand for fish products and declining capture fisheries, provide significant prospects for growth of the aquaculture sector.

Although the most recent FAO State of World Fisheries and Aquaculture Report (2014) found that Africa accounts for only 2.23 percent of global aquaculture production, it did highlight that annual aquaculture production growth was fastest in Africa (11.7 percent). Encouragingly, the average annual increase in fish production in the SADC region was 13.5 percent over the corresponding period. However, the development of aquaculture in the SADC region has not realised its full potential due to a poor grasp of the manner in which aquaculture works, including the technologies and methods, the business principles and the impacts (financial, social and environmental) thereof.

Between 2001 and 2013 aquaculture production (all species, including plants) in SADC Member States increased from 23 198 to 68 457 tons per annum (Table 1). The doubling of fish production volumes from 27 452 tons in 2009 to 56 063 tons in 2013 is largely as a consequence of growth in commercial cage culture of tilapia in Malawi, Zambia and Zimbabwe and trout in Lesotho. Gross revenue from aquaculture (excluding seaweeds) in the SADC region in 2013 exceeded US $ 247 million per annum, and over the 12 year period from 2001 to 2013 gross revenue grew at an average of 20 percent per annum. It should be noted however that commercial production by weight and value far exceeds production and revenue of the small holder sub sector. Approximately 77 percent of volume and 75 percent of revenue is attributable to commercial aquaculture.

Table 1: Aquaculture production statistics for SADC Member States (2001 - 2013) as extracted from the FAO Yearbook of Fishery and Aquaculture Statisrtics.

Aquaculture, excl. Plants (tons)	2001	2003	2005	2007	2009	2011	2013
Angola	11	72	126	190	260	310	310
Botswana	unreported						
Congo, Dem. Rep. of the	2744	2965	2965	2970	2970	2970	2869
Lesotho	8	4	1	131	108	300	500
Madagascar	7749	9467	9396	11293	6116	8845	8974
Malawi	568	666	812	1500	1620	2833	3705
Mauritius	59	33	400	175	437	537	425
Mozambique		409	1222	838	490	796	721
Namibia	50	75	125	334	536	434	610
Seychelles	282	1084	772	368			
South Africa	2818	3778	2895	2669	3433	3572	4010
Swaziland	72				73	100	100
Tanzania	300	2	12	45	202	648	3477
Zambia	4520	4501	5125	5876	8505	10530	20271
Zimbabwe	2285	2650	2502	2550	2702	7682	10090
Totals	**21466**	**25706**	**26353**	**28938**	**27452**	**39558**	**56063**

Aquatic Plants (tons)	2001	2003	2005	2007	2009	2011	2013
Madagascar	700	800	900	3650	3600	1699	3575
Mozambique		5230	560	690	230		
Namibia	20	67	67	27	130	130	130
South Africa	12	2824	3000	3000	1900	2885	2000
Tanzania	1000	2000	3000	4000	5520	6601	6689
Totals	**1732**	**10921**	**7527**	**11367**	**11380**	**11315**	**12394**

The production of seaweed in SADC has also increased significantly, by 9 percent per annum over the period 2001 to 2013; driven in particular by the demand for seaweed by the abalone farming industry in South Africa. Tanzania, and especially Zanzibar, remains the largest contributors to farmed seaweed in the region.

Overall this data shows that aquaculture output in the SADC region is on an upward trajectory. However, the small holder (non-commercial) sector has for all intent and purposes not shown much growth, the reasons for which, amongst others, include a lack of access to capital, infrastructure, fingerlings and appropriate feeds.

The development of commercial and largescale aquaculture has accelerated rapidly in several SADC Member States. Having seen the benefits of commercial aquaculture in terms of food security, job creation, income generation and other associated benefits, most SADC Members States have prioritised aquaculture development. This is reflected in the aquaculture development strategies of all members States. Member States are increasingly committing to the creation of appropriate platforms for access to, and optimal utilization of, available resources and infrastructure to expand a sustainable and competitive aquaculture sector that will meaningfully contribute to job creation, economic development, sustainable livelihoods, food security, rural development and equity, through increased production, and a diversity of production systems that produce safe and nutritious food, while safeguarding the environment.

2.3. REGIONAL AQUACULTURE VALUE CHAIN

Although the value chains for aquaculture in the SADC region are highly varied and diverse; determined by species, farming systems and markets, aquaculture can be broadly divided into two distinct forms:

i. Commercial aquaculture, which is market led and private sector driven for profit, and in many instances is export oriented.
ii. Small-holder aquaculture, which has been promoted by development partners and governments for over 50 years in sub-Saharan Africa with the aim to reduce poverty, create livelihoods and improve the rural food and nutritional supply situation. Small holder aquaculture is practised mainly in rural areas as a livelihood diversification strategy and plays an important role in providing high quality protein at the family level (Hecht, 2006).

The value chains for aquaculture are generally initiated through technology, know-how, opportunity or capital; sustained through the provision of stock (fingerlings), feeds and services; and terminated at the point of consumption. This simplification should be seen from the perspective that aquaculture value chains are generally short and unsophisticated at rural, small-scale and livelihood level and become increasingly complex as projects expand and become more commercially orientated. The nature of these value chains generally determine the dependence on resources, which in turn is generally correlated to the potential for environmental and social impacts.

2.4. REGIONAL CHALLENGES AND OPPORTUNITIES

Given the developmental, natural, social and economic diversity of the SADC Member States, it is challenging to isolate common challenges and opportunities in aquaculture. Nevertheless, the general conclusion is that the opportunities for aquaculture in the SADC region outweigh the challenges, and that the challenges can be overcome with strategic intervention, planning, cooperation and mitigation.

iii. Common aquaculture challenges in the region include:
   a. The shortage of sector specific skills and access to relevant information.
   b. A lack of access to finance, financial support and business acumen.
   c. Poor cooperation within and between countries.
   d. Regulatory frameworks that incorrectly contextualise the scale and nature of aquaculture, as well as a lack of adequate implementation of development strategies.
   e. Poor access to affordable feeds and quality stocks.
   f. Poor national and regional resource allocation for aquaculture development, with the potential of resource conflicts.
   g. Market competition with cheap, subsidized fish and fish product imports.
   h. The potential threat of aquaculture disease.
   i. Exotic species and the potential for environmental degradation where aquaculture is poorly planned and executed.
   j. Climate change.

v. Common aquaculture opportunities in the region include:
   a. A strong demand and market for fish and aquaculture products, linked to a decline in natural fisheries.
   b. In most countries water, climate and natural resources are conducive to a variety of aquaculture types.
   c. The region has access to a rich natural fauna and flora of potential aquaculture species.
   d. The sector enjoys strong political support and can rely on continental and international development partners.
   e. A strong international interest in commercial aquaculture development in the region.

2.5. ECOSYSTEM APPROACH TO AQUACULTURE

This framework advocates the ecosystem approach to aquaculture, which is defined as a strategy for the integration of the activity within the wider ecosystem, such that it promotes sustainable development, equity and resilience of interlinked social-ecological systems.

The ecosystem approach is not about what is done, but rather how it is done. To this end, the key principles of the ecosystem approach to aquaculture are:

i. Aquaculture should be developed in the context of ecosystem functions and services (including biodiversity), with no degradation of these beyond their resilience.
ii. Aquaculture should improve human well-being and equity for all relevant stakeholders.
iii. Aquaculture should be developed in the context of other sectors, policies and goals.

3. REGIONAL ENVIRONMENTAL ASPECTS

The following subsections identify and contextualise the important environmental aspects that relate to sustainable aquaculture development and operation, and provide the required approach and principles that should be adopted by each of the SADC Member States in pursuance thereof. These aspects do not represent an inclusive checklist of all the potential environmental impacts that may be relevant to any particular aquaculture project, but seek to provide a framework of the important environmental matters that need to be considered, managed, mitigated and monitored. In all instances, these aspects should be approached within the sovereign legal provisions of any particular SADC Member State.

Where appropriate, captions from the SADC Protocol on Fisheries (2001) and the FAO Code of Conduct for Responsible Fisheries (1995) follow at the end of certain subsections to emphasize the aspects that are covered, and the linkage of this framework to this overarching protocol and the code.

3.1. NATURAL RESOURCE NEEDS FOR AQUACULTURE

The development and operation of aquaculture depends on various natural resources and environmental services that range from water, to climate, to candidate species, feeds, energy and more. With reference to the ecosystem approach, aquaculture should be developed in the context of available ecosystem services, with no degradation of these beyond their resilience and long-term sustainability.

The preferred approach to natural resource allocation and use for aquaculture, includes:

i. Before any aquaculture is initiated, the natural resource and ecosystem service requirements must be determined as accurately as possible. These resource and service requirements must be compared to the availability thereof within the context of other users and the maintenance of environmental integrity.
ii. Natural resources, such as water and the ability of the environment to assimilate waste from aquaculture, must be used within the capacity and resilience of the environment to sustain such use, even in seasons and years of climatic extremes or natural disasters.
iii. In all instances the degradation and depletion of natural resources to achieve short-term production goals and profits, is unacceptable.
iv. Any natural resources that are degraded or depleted due to aquaculture activities must be timeously rehabilitated, and the nature or scale of the aquaculture operation curtailed to prevent any reoccurrence.
v. When considering production systems, production scales and candidate species, these must be selected in terms of the available natural resources and suitability of the climate and the surrounding environment to sustain production.

Section 9.1.3 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities".

3.2. WATER RESOURCES AND WATER QUALITY

Aquaculture needs water of a specific quality and quantity, which depends on the farming system, scale, species and management thereof. Given the high value of water resources on the African continent, the use of water must be done in a manner that considers other water dependencies and the sustainability thereof for human use and the maintenance of environmental integrity.

The preferred approach to water usage for aquaculture, includes:

i. As with other natural resources (see 3.1 above), the water resource requirement for aquaculture must be determined before establishment, so as to compare this requirement with the supply, within the context of other users and the maintenance of environmental integrity.
ii. Water needs must be determined with consideration to seasonal and annual climatic extremes, and mitigation measures must be devised for periods of water shortage.
iii. As with other resources, the degradation and depletion of water supplies to achieve short-term production goals and profits, is unacceptable.
iv. Measures must continuously be implemented (through new technologies and improved operational practices) to minimise the volume of water required, and towards limiting the potential for water pollution.

As an animal production activity, aquaculture adds nutrients, metabolites and other potential wastes to the water column, which creates the potential for water quality deterioration. Under correctly scaled and mitigated production conditions, the environment is able to assimilate such wastes, but inappropriate cleaning and use of water could lead to impacts such as eutrophication, fluctuation in water quality parameters such as dissolved oxygen, algal blooms, disease, changes in species composition and more.

The preferred approach to water discharge from aquaculture, includes:

i. The quality and quantity of all water discharged from aquaculture activities must be within the assimilative capacity of the receiving environment, in order to sustain environmental integrity without undue water quality and related impacts. Where applicable, sovereign water quality standards must be followed.
ii. In certain instances, the treatment of discharge water may be required to achieve discharge water quality criteria. Such treatment methods may include sedimentation, decantation, biological oxidation, filtration (chemically, physically and biologically), water recycling, nitrification, foam fractionation, carbon absorption, ion exchange, algal systems, ozone treatment and more. Residual materials removed by water treatment and filtration should be used for composting (where appropriate) or disposed of in an environmentally responsible manner.
iii. Where practical, nutrients or suspended solids can be removed by filter-feeding organisms (e.g. oysters and mussels) or aquatic plants. The use of discharge water for irrigation or in hydroponics can also be beneficial to the environment.
iv. Aquaculture feeding must be controlled through a specific feeding regime that maximises feed conversion efficiency, limits direct feed wastage and above normal faecal and metabolite release from the production organisms.
v. For cage culture on confined water bodies the upstream water resources, the water in which the production takes place and the downstream water resources should be monitored for quality related impacts. For marine and open water cage culture, water quality monitoring should be done at strategic points that represent scenarios for the baseline (i.e. uncontaminated) conditions and the post-impact conditions. This may consist of multiple sampling points depending on location, geography, currents and other factors.
vi. Where practical, the regular moving (site rotation) of cage culture systems may reduce localised water quality (and benthic) impacts.
vii. Where significant water quality impacts are detected, this can be addressed by lowering stocking densities, adjusting feeding rates, feed types and feed management, by increasing water displacement, improved filtration or by the moving of cage culture operations.

3.3. POTENTIAL USER CONFLICTS

Just as aquaculture development and operation requires natural resources and environmental services, other human and natural activities depend on these resources and services. The water, land and other resources required for aquaculture must be shared equitably and within the capacity of these with other activities such as agriculture, recreation, tourism, industrial and urban uses, and with the inherent requirement (reserve) for maintenance of the environment itself. This multi-user situation could lead to resource related conflict.

The preferred approach to potential resource conflict related to aquaculture, includes:

i. As indicated above, prior to the establishment of any aquaculture, the resource requirements must be quantified and the ability of the environment to provide these resources and services determined in context to their use by other legitimate users. This information must inform the scale and nature of the aquaculture venture.
ii. The expropriation of legitimately assigned natural resources should be discouraged, aside from situations where users deplete or degrade such resources.
iii. Where resource conflicts arise between the aquaculture and the fisheries sectors, attempts should be made to beneficiate fishermen in the aquaculture operations, or to equip and upskill these people to participate in the aquaculture sector.
iv. Where the abundance or nature of resources and ecological services change over time, all users must cooperate in equitably redistributing these to best suite human and environmental needs.
v. The impoundment of rivers, and other water management strategies and interventions, have to potential to both destroy existing (downstream) aquaculture opportunities, while creating new opportunities elsewhere. Where such challenges arise (especially for water use authorities and agencies), the impacts on existing aquaculture operations should be determined beforehand and alternative means of livelihood or empowerment in new aquaculture opportunities, pursued as a means of compromise.
vi. Where resource conflicts arise, these must be resolved by amicable and civilised intervention of authorities.

Section 9.1.4 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected by aquaculture developments".

3.4. EFFECTS OF ENVIRONMENT ON AQUACULTURE

In aquaculture development, most people only consider the directional effects of the operation on the surrounding environment and seldom consider the counter directional effects of a changing environment on the operation. Given the aquaculture sector's dependence on water resources that can be highly variable in quality and quantity, and which is susceptible to degradation by human activities, aquaculture is at risk of suffering from a range of external environmental effects.

The preferred approach to dealing with the external effects of the environment on aquaculture, includes:

i. As above, the water and other natural resource requirements for aquaculture must be comprehensively determined before any development. This includes a detailed understanding of the water needs, both quantitatively and qualitatively, and in relation to the seasonality or variability thereof.
ii. Where possible, water and other natural resources and services that aquaculture operations depend on should be monitored, and subcritical quality and quantity levels established to guide management actions and any interventions that may be required.
iii. Where the environment impacts on the maintenance of optimal farming conditions, the cause should

be determined. If the cause is related to human activities (shared resources), then the cause should be addressed as a first intervention. Failing this, the resource conflict resolutions indicated in the previous section should be pursued.

iv. Regardless of the cause of environmental effects on an aquaculture operation, internal migratory measures should be developed and implemented within practical and financial means.

3.5. MANAGEMENT OF FEED RESOURCES

Feed and feed management has the potential to cause both upstream supply related impacts and downstream effects through direct and indirect pollution of water resources and the environment. Sourcing, management and responsible use of feed is not only an important environmental consideration; it is also a key factor that often determines the financial viability of aquaculture.

The preferred approach to aquaculture feed, includes:

i. Only aquaculture feeds that are manufactured from sustainably sourced and traceable ingredients should be permitted. Through the globalisation of aquaculture, feeds are increasingly being sourced from distant locations, which has the potential to limit traceability in terms of quality, the ingredients and the sustainability thereof. Nevertheless, a reasonable attempt must be made to determine the nature and sustainability of feed ingredients.
ii. As a general rule, feeds should be used that offer sufficient quality and of which the ingredients, composition and manufacturing methods are known.
iii. Feed producers should provide the date of manufacture, ingredients (and origin thereof), information pertaining to the ideal storage conditions and estimated shelf life of feeds.
iv. Feed should be stored and used on a "first-in-first-out" basis to prevent unnecessary aging and deterioration in quality. Dampness, heat and vermin have the potential to spoil and consume feeds.
v. Where practical, a feed traceability programmes should be employed that can link feed batches to production cohorts.
vi. Feeds should be low in inedible fines (dust) and should be water stable.
vii. Feed types and feeding strategies are generally specific to each species, to the culture conditions, climate and growth stage. In this regard, feed types and feeding methods should be correctly selected. Palatable feeds of the correct pellet or grain size should be used to ensure low levels of feed loss. Other factors such as feed position (e.g. floating, sinking and distribution), water stability, feeding rate and feeding time of day must also be considered to minimise feed wastage.
viii. For the farming of specialist feeders, feeds must be specific. In all instances, feeds should be nutritionally balanced and serve the dietary needs of the farmed organisms.
ix. For large and commercial aquaculture initiatives, water quality monitoring should be correlated and checked against feeding rates and production biomass, so that adjustments can be made to the feeding programme if required.
x. Personnel that are responsible for feeding should be trained in feed application, so that they can detect subtle changes in feeding behaviour and adjust the feed application accordingly. Water current speed, flow rate, turbidity, barometric pressure, oxygen levels, wind, territorial behaviour, life stage, disease, stress and other factors may influence feeding and thus the feeding strategy should be flexible and adaptive, to ensure optimal intake and minimal wastage.
xi. Where automated or demand feeding is used, care must be taken to prevent over feeding and the feed application rate must be monitored.
xii. Growth and performance of aquaculture organisms should be monitored in relation to the quantity and quality of the feeds that are applied. Where appropriate, feed conversion ratios should be determined regularly so that the required interventions can be made timeously.

xiii. Where unprocessed feeds are used (e.g. trash fish or vegetable matter), special care must be taken to prevent over feeding and the maintenance of water quality.
xiv. Where fertilization is used to enhance algal and plankton blooms on which aquaculture organisms can feed, this must be done within the capacity of the water resource and in a manner that prevents the release of enriched water to the surrounding environment.

Section 6 in Article 13 of the SADC Protocol on Fisheries (2001) indicates that "State Parties shall undertake research and technological development, particularly in identifying new sources of locally available raw materials for fish feed".

Section 9.4.3 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should promote efforts which improve selection and use of appropriate feeds, feed additives and fertilizers, including manures".

3.6. CANDIDATE SPECIES AND BIODIVERSITY

The introduction of non-native aquaculture species into an environment could cause significant ecological disturbances, the introduction of new diseases, invasion and displacement of other species. This, coupled with the unseen and unpredictable ability of some species to escape from aquaculture facilities, makes the choice and management of candidate species important.

The preferred approach to candidate species and biodiversity, includes:

i. Where possible, preference should be given to locally indigenous and non-threatened species for aquaculture as opposed to alien, extralimital and invasive species.
ii. Prior to the commencement of any aquaculture activities, the use of any particular candidate species must be authorised in terms of the applicable sovereign legislation in SADC Member State.
iii. Where political, social and economic demands for the use of exotic aquaculture species threaten to overshadow potential ecological consequences, the scientific assessment of ecological risks associated with introduction of such species must enjoy absolute priority and must, insofar as this is possible, be undertaken by Member States. These risks must be evaluated in the broadest possible sense and not be limited to ecological considerations.
iv. When stocking aquaculture organisms, care must be taken to prevent unwanted secondary species from being accidentally introduced with the target species.
v. Where applicable, organisms for farming should not be collected from the wild. The establishment of brood stock populations is preferable in serving the stock needs of the aquaculture sector.
vi. It is recommended that the disease and parasitic status of introduced aquaculture organisms be evaluated, and that the risk of the species in this regard, be investigated in context to the area from which it originates, the area in which the aquaculture operation is located, and the degree to which any potential disease may pose a threat to the surrounding environment.
vii. Adequate steps must be taken to prevent the escape of aquaculture organisms, especially from the hatchery environment where individual organisms may be very small. In this regard, regular inspection of aquaculture infrastructure and escape barriers is important. Escape barriers may include netting, grids, screens, strainers, sand and other filters, predator ponds, chemical treatment areas, soak away systems and others. Such barriers should be adequate to prevent escape during flooding, overflow and during other unforeseen circumstances.
viii. In cage culture, the integrity of the nets should be inspected regularly and safety nets used to prevent the escape of fish during stocking, harvesting, sampling and grading.

Section 9.3.1 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should conserve genetic diversity and maintain integrity of aquatic communities and ecosystems by appropriate management. In particular, efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other States as well as waters under the jurisdiction of the State of origin. States should, whenever possible, promote steps to minimize adverse genetic, disease and other effects of escaped farmed fish on wild stocks".

3.7. GENETIC CONSIDERATIONS

The introduction of genetically different (including hybrids, genetically modified organisms and improved strains) aquaculture species into an environment could cause significant ecological disturbances as indicated in the previous section. As SADC Member States are signatories to the Convention on Biological Diversity (1992) and its associated Protocols, the goals thereof; including the conservation of biological diversity, sustainable use of its components and the equitable sharing of benefits arising from genetic resources, underpin this framework.

The preferred approach to genetic considerations, includes:

i. Aquaculture species that are able to hybridise should preferably not be farmed together, while species that are able to hybridise with indigenous species in the surrounding environment, should not be used as production candidates.
ii. The potential for genetic impacts should be established before introduction of any new aquaculture species. If found to be significant, such species should be avoided.
iii. Generally, aquaculture species are propagated from a limited or tailored gene pool and are usually not suitable for restocking or supplementation of natural stocks.
iv. The advancement of strain selection and selective breeding to improve the inherent genetic performance of aquaculture production organisms should be supported within the ambit of the Convention on Biological Diversity (1992).
v. In the near future, genetically modified (GMO) aquaculture species will become available for farming. Although the use of these enhanced organisms is not discouraged, it should be done with circumspection, especially in relation to the potential impacts on natural species and market perceptions. In all instances, such species may only be used in accordance with sovereign laws governing GMO matters.

3.8. DISEASE AND HEALTH MANAGEMENT

Aquaculture disease is a threat, not only because of its potential impact on production, but also due to the potential of infecting other organisms in the environment. Disease should be managed by pursuing prevention and implementing prepared strategies and actions for treatment. If mortalities occur (natural, through disease or other factors), the management thereof is important to prevent environmental impacts.

The preferred approach to disease and health management in aquaculture, includes:

i. All of the SADC Member States are signatories to the Aquatic Animal Health Code, issued by the World Organisation for Animal Health (OIE - Office International des Epizooties), and therefore this international disease code applies. None of the identified diseases in this code are permitted and are notifiable in terms of the code. If an identified disease is detected, the relevant authority (usually a State Veterinarian) must be informed immediately and the procedures prescribed code implemented.
ii. No aquaculture organisms should be introduced from an unknown source, or a source for which the disease status cannot be verified.

iii. Prior to the introduction of any foreign aquaculture organisms, the disease and parasitic status, and the risk of the organisms must be investigated in context to the area from which it originates, the area in which the aquaculture operation is located and the degree to which any potential disease may pose a threat to the surrounding environment. In certain instances the introduction of aquaculture organisms may require specific veterinary clearance, assessment, treatment or quarantine measures, which may be determined by specific sovereign legislation.
iv. Aquaculture operators should monitor the health status of aquaculture organisms as part of the daily operational activities. This includes water quality monitoring and the monitoring of the production conditions in addition to symptomatic monitoring of behaviour that can be supported by sampling, diagnostic dissection, microscopic investigation and more (as appropriate to the scale, species and nature of the aquaculture operation).
v. Although medicinal treatment should never replace sound husbandry and hygiene, treatment of aquaculture diseases must nevertheless be done by means of recognised methods and where applicable, under the guidance of a qualified veterinarian or fish health expert. All treatments must be recorded in detail to reflect the date, treatment methods, substances, dosages, withholding periods and outcome.
vi. If a disease breakout occurs, production systems should be isolated from each other and the surrounding environment (where practical). If required, a qualified veterinarian of fish health expert should be consulted to assist with further management interventions and treatments.
vii. Where applicable, the following practices should be implemented to reduce the risk of aquaculture disease:
    a. Predetermining the disease status of all introduced stock.
    b. Screening or quarantine of broodstock for known pathogens and parasites.
    c. Appropriate treatment of broodstock prior to entering the hatchery environment.
    d. Isolation and separation of production sectors with independent water supplies, access and equipment.
    e. Installation and use of foot baths and hand washing facilities for employees and visitors.
    f. Regular disinfection of equipment and working areas.
    g. Restricted on access to foreign vehicles and people.
    h. Management of bird and predator populations that could be disease vectors, and minimizing the potential for disease vector hosts to enter the aquaculture facilities.
viii. As it is not possible to eliminate all bacteria and parasites from an aquaculture facility, disease management requires a holistic approach, which includes the management of water quality, hygiene, feed, stocking densities, stress, predators, husbandry techniques and more.
ix. If mortalities are detected, the behaviour of the remaining stock must be monitored carefully. If large numbers die, the first step is to check the physical and chemical characteristics of the water and thereafter the possibility of disease. Orderly and daily notes must be kept of the numbers of dead organisms, the cause of death and the behavioural patterns of the population as a whole.
x. If production animals are injured or diseased to a point that causes excessive suffering, humane killing or euthanasia must be performed.
xi. Any dead organisms must be removed and disposed of in a manner that minimizes the spread of diseases. The equipment used to remove mortalities must be cleaned and sanitized.
xii. Where large scale mortality occurs, samples should be sent for diagnostic analysis and determination of the causative agents.

Section 9 in Article 13 of the SADC Protocol on Fisheries (2001) indicates that "State Parties shall monitor and exchange information on diseases and the spread of diseases of relevance to cultured aquatic species".

Section 9.4.4 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should promote effective farm and fish health management practices favouring hygienic measures and vaccines. Safe, effective and minimal use of therapeutants, hormones and drugs, antibiotics and other disease control chemicals should be ensured".

3.9. CLIMATE CHANGE

Climate change has become a global phenomenon, which is increasingly impacting human activities such as agriculture, and which is having specific impacts on the natural resource base (particularly water) and ecological services that aquaculture depends on. In certain instances climate change is resulting in areas becoming less favourable for certain species and types of aquaculture, while in other instances areas are being rendered more suitable. The FAO has worked extensively on the impacts of climate change on aquaculture and advocates an approach that includes both mitigation and adaptation. Given that reaction to climate change in the aquaculture sector will largely fall outside of planning or policy frameworks related to individual projects, the reaction to climate change must be done at a national level and through direction by SADC.

The preferred approach to climate change insofar as aquaculture in concerned, includes:

i. Although aquaculture is not a significant contributor to greenhouse gas emissions that cause climate change, mitigation measures such as improved energy use, more efficient transport, the localisation of markets and protection of environments that temper the acceleration of global warning, can be implemented.
ii. Adaption to climate change in the aquaculture sector includes the prudent location of new aquaculture development in less affected or alternative areas, investment in more resilient production systems and methods, the use of adaptive or less sensitive aquaculture species, or the switching to species that become new aquaculture candidates due to a changed climate.

3.10. PRODUCT SAFETY AND CONSUMER HEALTH

As the end user of aquaculture products are consumers, the safety and quality of the products that the sector produce, must, in all instance, be safe for human consumption and use. Measures that ensure high standards of quality and safety, by implication, will also reduce post-harvest losses.

The extent to which product safety in aquaculture needs to be management and monitored depends largely on the type of production systems and the final destination and markets for the products (e.g. small scale rural production for food security vs. large scale commercial operations for export markets).

The preferred approach to product safety and consumer health, includes:

i. The quality of aquaculture products rely principally on safe, hygienic production and handling that meets local safety standards and/or external standards such as those set by accreditation organisations (e.g. the International Organization for Standardisation (ISO) or many other standard based labelling initiatives), as well as individual country standards or client needs.
ii. At commercial projects focussed on supplying to formal markets, the implementation of lesser or greater detailed versions of a Hazard Analysis Critical Control Point (HACCP) system has become commonplace in assuring food safety and quality. HACCP is based on the identification of risks, minimizing those risks through design, layout and producers in the physical environment in which high standards of hygiene can be assured, while establishing measurable criteria and monitoring systems.
iii. Public health issues can be grouped as either environmentally induced (sub-divided into natural and anthropogenic), process induced, or distribution and consumer induced hazards. For aquaculture

initiatives, these potential issues must be identified and the risk managed effectively.

iv. Where appropriate, the implementation of a continuous cold chain can greatly enhance the achievement of aquaculture product quality criteria and food safety standards.
v. Aquaculture operators and other employees must be trained in hygienic farming methods and the maintenance of sanitary conditions when working with aquaculture products.
vi. Only recognised additives and medications may be used in aquaculture and in all instances any withholding periods or declaration requirements must be strictly complied with.

Section 9.4.5 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should regulate the use of chemical inputs in aquaculture which are hazardous to human health and the environment".

Section 9.4.7 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should ensure the food safety of aquaculture products and promote efforts which maintain product quality and improve their value through particular care before and during harvesting and on-site processing and in storage and transport of the products".

4. REGIONAL SOCIO-ECONOMIC ASPECTS

The following subsections identify and contextualise the important socio-economic aspects that relate to sustainable aquaculture development and operation, and provide the required approach and principles that should be adopted by each of the SADC Member State in pursuance thereof. These aspects do not represent an inclusive checklist of all the potential socio-economic impacts that may be relevant to any particular aquaculture project, but seek to provide a framework of the important socio-economic matters that need to be considered, managed, mitigated and monitored. In all instances, these aspects should be approached within the sovereign legal provisions of any particular SADC Member State.

Where appropriate, captions from the SADC Protocol on Fisheries (2001) and the FAO Code of Conduct for Responsible Fisheries (1995) follow at the end of certain subsections to emphasize the aspects that are covered, and the linkage of this framework to this overarching protocol and the code.

4.1. ACCESS TO LAND, WATER & OTHER RESOURCES

As indicated in Sections 3.1 to 3.3, aquaculture requires land, water and other natural resources that may not be freely available to all. It is generally assumed that large commercial entities have the financial recourse and acumen to determine their natural resource needs and to endeavour for the establishment of aquaculture facilities in suitable areas. Yet, individual persons, especially the destitute and impoverished, have a limited ability to access such natural resources for aquaculture. With due consideration to the ecosystem approach, access to resources for aquaculture development should be equitable and within the context of the available ecosystem services.

The preferred approach in dealing with access to land, water and other resources for aquaculture development, includes:

i. Individual SADC Member States should spatially identify land and water resources that are suitable to aquaculture development. In many instances people reside within, or in proximity to these resources and have not been able to develop aquaculture due to factors such as a lack of knowledge and skills, limited availability of stock and key services and more. This spatial exercise could lead to the formation of aquaculture development zones or clusters, and people should be empowered by equitable access to these natural resources for aquaculture development.
ii. Individual SADC Member States should provide preferential access to land and water resources for sustainable aquaculture development, and should stimulate such aquaculture development by the provision of incentives and essential services that can eliminate barriers to entry.
iii. Where water impoundment, storage and distribution infrastructure is implemented and operated, and where traditional crop irrigation is practiced, people and organisations should be encouraged to consider the integrated use of water for aquaculture, in combination with primary and other water uses.
iv. Where commercial aquaculture is allowed to develop, these operations should be encouraged to empower people by sharing resources for aquaculture development equitably.

4.2. ZONING AND CLUSTERING

As indicated in Section 4.1 above, national or regional spatial planning around suitable resources for aquaculture development and operation could lead to the formation of aquaculture development zones or clusters. Such aquaculture zones are advantageous in that they create opportunities for the establishment of collective infrastructure and support services, provide a platform for the sharing of skills and have the potential to reap the benefits of economies of scale. Moreover, such zones or clusters provide opportunities to access volume and/or variety driven markets for seafood.

The preferred approach to zoning and clustering for aquaculture, includes:

i. As indicated in Section 4.1, individual SADC Member States should spatially identify land and water resources that are suitable to aquaculture and endeavour to develop these areas as clusters or zones, by the provision of services, skills and other incentives.
ii. Clustering can cause biosecurity and disease related concerns and it is recommended that Member States play a key role in the monitoring and management of disease related matters that could impact on such clusters.
iii. It is recommended that Member States play a key role in assisting with the empowerment of people to establish aquaculture in these cluster areas and that they endeavour to secure the required skills to assist new farmers.
iv. It is recommended that Member States play a role in the development of markets for clustered aquaculture initiatives, but that free-market principles remain unhindered.
v. Member States are cautioned against marginalisation or regulatory burdening of aquaculture efforts that are undertaken outside of identified zoning or clustering schemes. The very nature and essence of entrepreneurship and innovation does not always lie in conformity.

4.3. RESEARCH AND APPLICATION OF TECHNOLOGY

The development of aquaculture competes for natural resources and environmental services with traditional agriculture, industry, mining, tourism and many other human endeavours. This, coupled to the increasing demands for efficiency, food security and increasing global market sophistication, means that aquaculture development on the African continent will have to become more adept with technological advancement in the sector. This does not always imply the application of foreign technologies, but includes the local development of region specific technologies and farming methods that are best suited to local conditions and/or the use of foreign technologies in a manner that allows for local optimisation. In order to achieve this, and to address the growing need for advancement of aquaculture methods, the SADC Member States must cooperate around aquaculture research and technology development.

The preferred approach to research and the application of technology, includes:

i. Where new candidate species are identified for aquaculture, the best available technologies that are suitable to the local conditions, and that are within the scope and resources of the aquaculture project, must be sought and implemented to achieve optimal production. The best suited technologies are not always the most expensive or most complicated systems.
ii. The application of advanced technologies must be extended to feeds, broodstock and hatchery practices, processing and other areas related to aquaculture production.
iii. SADC Member States are encouraged to share workable technologies in the region.
iv. Tertiary education institutions in the SADC region are encouraged to cooperate around access to, and the determination of regional research needs for aquaculture.
v. The SADC Secretariat should establish and maintain a regional aquaculture research inventory and cooperative platform, which should also play an active role in promoting the regional research dialog for the sector.

Section 3 in Article 13 of the SADC Protocol on Fisheries (2001) indicates that "State Parties shall promote on-site research, demonstrations and increased practitioner-to-practitioner extension as ways to increase economic and social benefits from aquaculture".

4.4. ACCESS TO KNOWLEDGE AND SKILLS

Much of the aquaculture potential in the Southern African region is underutilised due partly to a critical shortage of knowledge and skills. Aquaculture is not a traditional endeavour in the region, and in most instances the skills and knowledge that is required for undertaking aquaculture must be learnt, transferred or developed over time. To empower local people in aquaculture, the SADC Member States must play an active role in knowledge and skills development and transfer.

The preferred approach to knowledge and skills for aquaculture, includes:

i. As with the application of technology in Section 4.3, the best possible and most applicable bank of knowledge must be used when developing aquaculture projects. Knowledge must the tailored to suite local conditions and the chosen candidate species.
ii. While the development of local curricula in aquaculture at training institutions is encouraged, on-farm and practical training in sector skills is vital. Learnerships and internships must be actively sought for people that intend pursuing aquaculture.
iii. SADC Member States are encouraged to share knowledge.
iv. Tertiary education institutions in the SADC region are encouraged to cooperate around development and access to knowledge for the sector.
v. The envisaged SADC research inventory and cooperative platform indicated in Section 4.3 (v) should be used as a platform to promote knowledge development and dissemination. In this regard, this platform should activity pursue and disseminate the wealth of aquaculture information generated by the FAO, WorldFish, the NEPAD, the AU-IBAR and others.
vi. SADC Member States are encourage to establish and vitalise extension services to better disseminate aquaculture knowhow. It is essential that extension officers be trained in aquaculture skills and knowhow, so as better to equip them to transfer this knowledge.

4.5. HUMAN RESOURCE DEVELOPMENT

Coupled to the aspects on knowledge and skills in Section 4.4 above, is the need to develop and support the human resources required in the development of the aquaculture sector. Aquaculture requires a set of specific skills that have to be learnt.

The preferred approach to human resource development for aquaculture, includes:

i. The collection and dissemination effort of knowledge referred to in Section 4.4 must be accessible to entrepreneurs that wish to develop aquaculture opportunities. In this regard, SADC Member States should facilitate field days, practical demonstrations and lectures to assist with knowledge dissemination and transfer.
ii. The youth of the Southern African region should be exposed to aquaculture from a young age, through practical demonstrations and through incorporation thereof in schoolwork, alongside the concepts of traditional agriculture.
iii. Member States should seek opportunities for learnerships and internships at established commercial aquaculture operations.
iv. As indicated in Section 4.4, SADC Member States should establish and vitalise extension services to better disseminate aquaculture knowhow. Experience has shown that teaching aquaculture skills in isolation is of little value if this is not supported by business knowhow, marketing, product handling and other supportive and associated knowledge.

4.6. EMPOWERING THE MARGINALISED

In most instances, commercial and large scale aquaculture is self-sufficient in terms of establishment, growth, development and progress. This is however not the case with marginalised communities that rely on subsistence agriculture, labour sending practises, natural resource harvesting and sale, and other related livelihood options. These marginalised communities often suffer from extreme poverty, high levels of illiteracy, are food insecure and exposed to social ills like alcohol abuse, trafficking and domestic violence. In order to collectively prosper as a region, these communities must be empowered to participate in the economy.

The preferred approach to the empowerment of marginalised communities in aquaculture, includes:

i. Marginalised communities that lie in proximity to natural resources such as land and water that is suitable for aquaculture, must be identified as potential beneficiaries of aquaculture development. In order to do this, people from such communities must be actively upskilled in aquaculture, so that they can develop projects or become employable in the sector.
ii. Smallholder aquaculture for subsistence is possible, but often fails due to the burden of low economies of scale, the lack of financial returns that can be ploughed back into production and a lack of knowledge, skills, services and markets. Where smallholder aquaculture can overcome some of these challenges and access natural resources with a low opportunity cost, this should be pursued, but generally requires a certain level of ongoing State support. Empowering people in projects that are geared to generate profit, regardless of how small and regardless of the limited market that it serves, is a better alternative as opposed to subsidised aquaculture development.
iii. Access and dissemination of knowledge and skills, in all fields that support aquaculture developed and operation, as indicted in Sections 4.4 and 4.5, is imperative in empowering marginalised communities.

Section 9.4.1 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should promote responsible aquaculture practices in support of rural communities, producer organisations and fish farmers".

4.7. SMALL HOLDER & COMMERCIAL LINKAGES

Commercial and large scale aquaculture enterprises generally operate at a scale of economy that allows for access to services, resources (especially feed and skills) and markets. Tapping into these services can be an effective springboard that can support existing and new smaller aquaculture projects that can be used to empower local people and communities, and which can be used in the pursuance of economic self-sufficiency for these projects. Establishing smaller projects around the hub created by largescale commercial ventures does not necessarily imply that the smaller projects have to produce the same products, or compete in the same markets. Small-scale projects can also be established to support larger projects (with feeds, supplementary products or employment ready people), or products from smaller projects can be sold on and traded by the larger entities.

The preferred approach to linking small holder aquaculture to commercial projects, includes:

i. The facilitative role that larger and commercial aquaculture projects can play, must be encouraged and, where appropriate, enforced through licencing and trade conditions that benefit all parties.
ii. Innovation in terms of the provision of local services (such as transport, labour etc.) and support products (feed, equipment etc.) from local communities to large scale and commercial aquaculture projects, should be actively pursued.
iii. Where possible, large and commercial aquaculture ventures should be encouraged to use local services and products. In addition to this, large and commercial ventures must be encouraged to support satellite production systems and local value adding initiatives (such as processing) for aquaculture products.

4.8. CONDUCIVE AND SAFE WORKING CONDITIONS

Although aquaculture does not generally create unsafe working conditions, operations that make use of floating cages and large pond based production systems, could pose drowning hazards to people that are not proficient swimmers. General workplace hazards that are common to any type of farming also occur. In addition to ensuring that the workplace remains safe, employees and workers should be treated with adequate dignity and in accordance with their specific rights.

The preferred approach to conducive and safe working conditions, includes:

i. Basic legal employment conditions must be upheld to ensure the maintenance of employee rights.
ii. Working conditions on aquaculture facilities must be such that they are safe. Where required, the necessary safety equipment (such as life jackets), training in their use and the required emergency responses (such as the measures that should be applied when a person is drowning), must be implemented.
iii. Adequate protective gear must be provided for certain tasks such as the handling of chemicals and working on floating cages.
iv. Provision must be made at aquaculture facilities for ablution facilities, clean drinking water and an area where employees can take shelter against inclement weather and where they may store personal goods and belongings.
v. Aquaculture facilities and operations must make provision for first aid equipment and at least one employee should be trained in first aid provision. Relevant emergency service contact numbers should be clearly displayed at all facilities.
vi. Employees must be provided with opportunities for training and furtherance of their skills.
vii. Pursuant to gender equality, employment opportunities in aquaculture must be made available to men and women, with due consideration that certain activities, such as working of floating cages, is better suited to men, while post-harvest processing is better suited to women.
viii. Although opportunities should be created in the aquaculture sector for the youth, child labour practices are not acceptable.

4.9. MARKET DEVELOPMENT AND TRADE

The offset for aquaculture products range from highly sophisticated international markets to highly localised (sometimes rural) sale and trade points. For this reason, the development of markets for sustainable aquaculture products is a highly complex and detailed field of study. In this framework document an attempt is made to include just a few core aspects related to market development and trade.

The preferred approach to market development and trade for aquaculture, includes:

i. Through research done by the FAO, it is generally accepted that selling the smallest possible size of an aquaculture organisms that the market will accept, creates to highest profit margin and lowest risk. This is however a generalisation and does not apply universally.
ii. In all instances, products produced through aquaculture must be safe for human consumption (see also Section 3.10 that deals with product safety and consumer health).
iii. Wherever possible, the adding of value to primary aquaculture products through further processing, packaging and enhancement should be done locally, to optimise profitability and to capture a greater share of the value chain for local participants and beneficiaries.
iv. Where possible, and specifically for formal and export market orientated aquaculture projects, a product traceability system should be employed to assist with quality control.
v. The use of eco-labelling should be encouraged as the global market for aquaculture products becomes increasingly attuned thereto.

vi. SADC Members States must actively develop means of supporting the export of aquaculture products to contribute to the generation of foreign revenue.

vii. Local and rural markets for aquaculture products should strive for the maintenance of quality standards, but must not be limited by overregulation.

5. REGIONAL TOOLS IN AQUACULTURE DEVELOPMENT

A number of tools exist to better pursue the development and operation of sustainable aquaculture in the Southern African region, and to better pursue the implementation of the ecosystem approach (see Section 2.5). Many of these tools have been developed and tried internationally, and compressively recorded in works by the FAO and other bodies.

Where appropriate, captions from the SADC Protocol on Fisheries (2001) and references to works by the FAO have been included in some of the following subsections to provide further guidance.

5.1. SPATIAL PLANNING TOOLS FOR AQUACULTURE

As indicated in Sections 3.1 to 3.3, the location of aquaculture, as well as the clustering and zoning of thereof (see Section 4.2), requires high level spatial planning to ensure that the aquaculture type and species is adequately matched to the receiving environment, and to ensure that the natural resources and environmental services can sustain the operation. In today's modern age, advanced spatial and resource planning tools are available and should be used in the development of sustainable aquaculture in the SADC region.

Spatial planning tools for aquaculture include the use of GIS, remote sensing, mapping, land use and resource characterisation and capacity modelling. These tools are comprehensively discussed by the FAO in "The Potential of Spatial Planning Tools to Support the Ecosystem Approach to Aquaculture" (2010) and the joint FAO/World Bank policy brief "Aquaculture Zoning, Site Selection and Area Management under the Ecosystem Approach to Aquaculture" (2015).

5.2. PROJECT PLANNING TOOLS

Traditionally, the planning of large scale and commercial aquaculture was heavily dependent on the implementation of environmental impacts assessments (EIA's), while small scale and rural aquaculture was generally allowed to develop organically, with little environmental planning.

Internationally, many interpretations of the exact steps and processes in EIA abound and most countries have promulgated laws and regulations that govern EIA procedures internally. EIA processes essentially consists of consecutive steps involving screening to determine the need and scale of assessment, scoping to identify an inventory of potential impacts, impact prediction and recording thereof in a statement; all of which, together with measures for mitigation, are subjected to public participation and reiteration.

For aquaculture zones, clusters and for national development initiatives the use of strategic environmental assessment (SEA) has become increasingly relevant. SEA follow similar steps to an EIA, but is generally conducted over a broader geographical scope or for determining the environmental consequences of policy and strategy interventions.

This framework advocates the implementation of the ecosystem approach to aquaculture planning and development (see Section 2.5), in which aquaculture planning and implementation must be done within the capability of the ecosystem, for the benefit of people and with due consideration to multiple natural resource dependencies. The ecosystem approach is not in conflict with the application of EIA's and SEA's, but places a greater emphasis on the ability of the ecosystem to sustain human (aquaculture) activities within the needs of people and the ability of the environment.

It is imperative that SADC Member States play a greater role in facilitating SEA's to lessen the burden of project specific EIA's on individual projects, especially smaller scale projects. Moreover, certain potential impacts of aquaculture are common and generic (e.g. water use, feed related waste issues, medication etc.), and these should be strategically determined and assessed to allow for an easing of the EIA requirements.

In all instances, small scale and rural aquaculture development that poses the potential for limited impacts, and with a limited ecological footprint, should not be taxed and discouraged through complex legislative requirements in EIA's. In this regard, the farming of small volumes of indigenous aquaculture organisms, should be encouraged to proceed without the need for complex EIA processes.

Section 8 in Article 13 of the SADC Protocol on Fisheries (2001) indicates that "State Parties shall establish standard guidelines and regulations for the application of environmental impact assessments".

Section 9.1.5 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities".

The FAO has published guidelines such as the "Environmental Impact Assessment: Guidelines for FAO Field Projects" (2011) and "Environmental Impact Assessment and Monitoring in Aquaculture" (2009), which are helpful in EIA planning for aquaculture.

5.3. IMPACT MITIGATION TOOLS

Once an aquaculture initiative has been planned and established in terms of the ecosystem approach, the implementation of certain mitigation tools are required to ensure that potential impacts do not pose an unaccepted risk to the sustainable use of the environment. After the potential impacts are determined in an EIA or SEA process, the tempering of such impacts should be associated with such migratory measures, which should be recorded in an Environmental Management Programme (EMP). Such EMP's should deal with the mitigation measures in the establishment (construction), operational and decommissioning phases and should provide clarity on the assignment of responsibilities, mapping, environmental method statements, environmental training and education, contingency planning, rehabilitation planning and monitoring measures.

5.4. MONITORING TOOLS

The monitoring of potential impacts of aquaculture development and operation is the only reliable means by which the manifestation of these impacts can be determined and tracked over time. In all instances, monitoring of impacts must be relevant to the scale and potential effect of impact manifestation (i.e. monitoring for the sake of monitoring is of little value). The following aspects are typical of aquaculture monitoring programmes, but depend on the scale, species and nature of the operations:

i. Water and potential degradation of water quality.
ii. Monitoring of the surrounding environmental integrity.
iii. Waste generation and discharge.
iv. Disease status, organism health and application of treatments and medications.

Where possible, small scale and rural aquaculture development with a limited ecological footprint, should not be taxed with monitoring. Likewise, Member States should lessen the monitoring burden on large and

commercial projects by undertaking as much thereof as possible as a State service.

Environmental auditing is an important component of monitoring. In this regard SADC Members States are encouraged to use auditing as a tool to improve compliance, and also as a tool to cooperate around environmental accountability and the raising of standards in the aquaculture sector.

The aforementioned FAO publication "Environmental Impact Assessment and Monitoring in Aquaculture" (2009), is helpful in determining the monitoring needs for aquaculture.

5.5. STANDARDS AND BEST PRACTICES

One of the intentions around the monitoring of impacts as indicted in Section 5.4, is to determine whether aquaculture operations meet acceptable criteria and standards. Few environmental standards have been determined by SADC Member States for environmental variables associated with aquaculture. In this regard, the development of regional standards, based on the nature of the receiving environment and the nature and scale of aquaculture operations, should be prioritised, both to safeguard the environment and to improve accountability.

Increasingly, commercialised aquaculture projects are faced with certification schemes and eco-labelling initiatives that promise preferential access and premium pricing in certain markets. Initially, such certification schemes were of little value, but they have progressively become more important in accounting for responsible and sustainable production activities. It is therefore likely that international and niche market access will become increasingly difficult without subscription to such schemes. From a regional perspective, Member States should promote the adoption of reputable certification and labelling programmes.

The FAO has worked on determining means of recognition for acceptable certification schemes for aquaculture and have published materials such as the "Technical Guidelines on Aquaculture Certification" (2011) and "Private Standards and Certification in Fisheries and Aquaculture" (2011).

5.6. ENHANCING POSITIVE IMPACTS

The determination of aquaculture impacts, EIA and SEA processes and the ecosystem approach, often focus solely on potential negative impacts, and forgo the opportunity to identify and enhance the positive ecological and socio-economic impacts of aquaculture. Ultimately, the establishment and existence of an aquaculture project must provide for a beneficial trade-off and balance between ecological, social or economic advantages that support viability. As with many human endeavours, and agriculture in particular, the net positive environmental or ecological impact of aquaculture is usually limited, but these are generally outweighed through trade-off with social and economic advantages such as employment, skills development, food security, the creation of economic opportunities and more. Given the importance of using such a trade-off model of negative and positive impacts, it is imperative that the potential positive impacts of aquaculture be enhanced by means of interventions such as the optimisation of employment, the development of rare skills, the creation of local economic benefits and spinoffs and the provision of direct or indirect food security.

6. INSTITUTIONAL ARRANGEMENTS

The institutional arrangements around the use and implementation of this framework depend directly on its adoption by SADC Member States and the related facilitation of implementation through interventions and efforts of the AU-IBAR and SADC.

6.1. POLICY FRAMEWORKS IN THE REGION

Section 1.5 provides insight into the alignment of this framework to other regional and international frameworks, codes and protocols. Of specific importance is that this framework to environmental management for sustainable aquaculture, is strongly aligned to the objectives of Article 13 in the SADC Protocol on Fisheries (2001), and broadly to other policies, protocols and strategies of SADC. In parallel to this, this framework has been developed in accordance with the AU-IBAR Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (2014) and the AU-IBAR Guide for the Implementation of the Policy Framework and Reform Strategy for Fisheries and Aquaculture in Africa (2015).

It is expected of SADC Member States to incorporate the content of this framework into internal policies and strategies related to aquaculture and aquaculture development. Moreover, this will contribute to a greater level of adoption of the SADC Protocol on Fisheries (2001).

6.2. TRANSBOUNDARY CONSIDERATIONS

In many instances the resources (particularly water) that support aquaculture or aquaculture development, are shared between two or more countries through common borders on rivers, lakes and in marine habitats. These areas must be managed around the common good for both countries, which will inevitably depend on close cooperation and mutual respect. In such instances, aquaculture development and operation must take place through liaison between the two countries, through equitable sharing of natural resources and environmental services, through the sharing of support and benefits and through collective accountability.

Section 9.2.1 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should protect transboundary aquatic ecosystems by supporting responsible aquaculture practices within their national jurisdiction and by cooperation in the promotion of sustainable aquaculture practices".

Section 9.2.2 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should, with due respect to their neighbouring States, and in accordance with international law, ensure responsible choice of species, siting and management of aquaculture activities which could affect transboundary aquatic ecosystems".

Section 9.2.3 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should consult with their neighbouring States, as appropriate, before introducing non-indigenous species into transboundary aquatic ecosystems".

6.3. REGIONAL COOPERATION

The successful adoption and implementation this framework depends on regional cooperation between the SADC Member States and between Member States, the SADC Secretariat and the AU-IBAR. The SADC Secretariat and the AU-IBAR will play a leading role in the facilitation of cooperation, but each Member State should endeavour to enhance their participation and cooperation in the regional advancement of the aquaculture sector in accordance with the principles contained in this framework.

Section 9.2.4 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should establish appropriate mechanisms, such as databases and information networks to collect, share and disseminate data related to their aquaculture activities to facilitate cooperation on planning for aquaculture development at the national, subregional, regional and global level".

Section 9.2.5 of the FAO Code of Conduct for Responsible Fisheries (1995) indicates that "States should cooperate in the development of appropriate mechanisms, when required, to monitor the impacts of inputs used in aquaculture".

6.4. IMPLMENTATION OF THE REGIONAL FRAMEWORK

This framework on the management and development of sustainable aquaculture includes a number of aspects and principles that will improve the environmental profile and management of regional aquaculture development and operation, to the benefit of all the SADC Member States and their citizens. With the SADC Secretariat and the AU-IBAR leading the compilation and coordination of implementation, the following implementation arrangements are recommended:

i. Along with the SADC Protocol on Fisheries (2001), this framework should be adopted into sovereign policies and development strategies for aquaculture in each of the SADC Member States.
ii. Sections 4.3 and 4.4 speak to the establishment of a cooperative platform for SADC Members States, which should be coordinated by the SADC Secretariat and which will have other functions such as the creation and maintenance of an aquaculture research inventory. This platform should serve as the central hub for this framework, for the development of best practices for the sector, for the regional coordination of research, regional dissemination of aquaculture information, regional linkages with sector experts and other cooperative initiatives related to regional aquaculture development and operation.
iii. The cooperative platform above should be vitalised by the identification of aquaculture focal points in each of the SADC Member States. Such a focal point should ideally be seated within the State machinery. Although it should be identified by a Ministry, Department or State Organ, it should also be attached to a specific person or persons with the responsibility of acting as the regional aquaculture contract person for a specific SADC Member State. The SADC Secretariat should maintain and update the list of aquaculture focal points.
iv. The cooperative platform should aspire to becoming a regional information depository for aquaculture. This should include regional development and production statistics and trends, FAO and other knowledge sources and results of regional aquaculture research.
v. It is recommended that the SADC Secretariat use the cooperative platform to establish active regional communication networks through the aquaculture focal points, so as to more effectively disseminate information. The aquaculture focal points should ideally meet at least annually to discuss regional aquaculture development issues, constraints and solutions to sector development and operative challenges. Such deliberations should also be used to update and develop this framework further.
vi. It is recommended that this framework be used as a strategic forerunner to the development of specific regional aquaculture standards, which could also be tailored to specific subsectors (e.g. prawn farming, tilapia farming, cage farming etc.).

6.5. FUNDING OF FRAMEWORK INTERVENTIONS

It is expected of each SADC Member State to provide for its own internal funds as required for the adoption and incorporation of the framework principles into sovereign policies and strategies related to aquaculture. Moreover, each Member State's aquaculture focal point should be based within the existing State machinery.

The SADC Secretariat and the AU-IBAR will fund and facilitate the establishment and coordination of the central cooperative platform.

7. CONCLUSION

This Regional Framework on Environmental Management for Sustainable Aquaculture Development in Africa - Southern African Region seeks to support the advancement of aquaculture in the SADC region, by providing guidance around the establishment and operation of an aquaculture sector that can thrive within the capacity of natural resources, which is accountable and which results in tangible benefits for the people of the region.

There are significant challenges in maintaining and protecting the environment upon which aquaculture depends. Addressing these challenges will depend on regional cooperation, innovative thinking and a collective commitment to long-term sustainability. This is only possible through the development and dissemination of good-quality, relevant, up-to-date and accessible information, in a cooperative effort to establish aquaculture as a globally important sector in the Southern African region.

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African Union – Inter-African Bureau for Animal Resources
(AU-IBAR)
Kenindia Business Park
Museum Hill, Westlands Road
PO Box 30786
00100 Nairobi
Kenya
Tel: +254 (20) 3674 000
Fax: +254 (20) 3674 341 / 3674 342
Email: ibar.office@au-ibar.org
Website: www.au-ibar.org