October 2016

## SEYCHELLES FISHING AUTHORITY

# Visual Impact Assessment for the Proposed Seychelles Mariculture Master Plan

**Submitted to:**
Seychelles Fishing Authority

## DRAFT FOR COMMENT

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# 1.0 INTRODUCTION

## 1.1 Background

Golder Associates (Golder) have been appointed by the Seychelles Fishing Authority (SFA) as independent environmental assessment practitioners (EAPs) for the purpose of conducting an Environmental and Social Impact Assessment (ESIA) for the proposed implementation of the Seychelles Mariculture Master Plan (MMP).

This visual impact assessment (VIA) is one of the specialist studies conducted in support of the ESIA which has been compiled in line with the requirements of local Seychelles legislation and aligned with international best practice.

## 1.2 Project Description

The Mariculture Master Plan (MMP), which would guide the development of a Mariculture (also known as Aquaculture) sector in the Seychelles, comprises four main zones, namely:

- Land-Based Zone Aquaculture;
- Inshore Zone Aquaculture (not covered by this ESIA);
- Aquaculture Development Zones (ADZs); and
- Offshore Zone Aquaculture (not covered by this ESIA).

Carrying capacity scenarios were created based on a high-level assessment of potential factors that would determine the potential expansion of the industry. These included; conflict with existing resource users, market demand and availability, infrastructure, and innovative technology in other aquaculture industries e.g. the salmon industry in Norway.

Three possible carrying-capacity scenarios with different aquaculture development opportunities have been identified:

- The low-road scenario;
- The mid-road scenario; and
- The high-road scenario.

This ESIA focuses on finfish cage culture within the ADZs, which makes up a component of the mid-road scenario.

During the site selection and evaluation process of potential ADZs, a number of sites were identified and initially 16 were shortlisted. After a thorough analysis of the prevailing bio-physical and social receptors at each site, the number was reduced to 12 ADZs which were taken forward in this ESIA.

Due to the nature of the industry development, operators may end up using different cages, feeding technologies as well as other support infrastructure i.e. well boats or workboats.

The project components covered under this ESIA and assessed in this VIA are presented below:

### 1.2.1 Land-Based Zone Aquaculture

As part of land-based aquaculture, a Research & Development (R&D) Facility and Broodstock Quarantine & Acclimation Facility (BQAF) will also be built on Mahé. Both facilities will be multipurpose buildings and will be important for sustainable growth and development of the MMP.

**Broodstock Acclimation and Quarantine Facility:**

The Seychelles BQAF will be a multi-species quarantine and acclimation facility that provides quarantine treatments for wild-caught broodstock, and prepares these fish for life and reproduction in captivity at the Anse Royale R&D Facility, discussed further below. Broodstock are a group of mature individuals (fish) which are used in aquaculture for breeding purposes. It should be noted however, that for the initial pilot project cycle, fingerlings may need to be imported.

These broodstock will form the basis of production at the hatchery and broodstock selection, quarantine and acclimation are therefore of utmost importance in ensuring the successful production of juvenile fish at the R&D Facility. The BAQF is designed to ensure that broodstock are well cared for, readily adjust to captive conditions, spawn and produce good numbers of high quality eggs, have fewer disease problems and greater longevity. The broodstock will be sourced from Seychelles waters, mitigating any genetic or other environmental risks associated with the importation of exotic fishes.

The BAQF is located in Providence, Mahé (Figure 1 and Figure 2). The site is located at the Providence Harbour adjacent to the shoreline providing convenient access to water supply and cost-effective pumping with minimal head (water pressure). Bulk infrastructure including port infrastructure, unused existing warehousing, electricity and fresh water is available at this site, which also has existing road access. Facilities including ablutions and offices are also available on site. This site also has the benefit of being located adjacent to the SFA Providence Office.

**Pilot Project Cage Site:**

The planned Pilot Project forms a strategic link between the activities of the R&D Facility and the commercial scale projects. The Pilot Project is scaled at 200 tonnes per annum and aims to grow-out candidate species to a marketable size for sale in the domestic market and for shipment as product samples to target international markets.

The Pilot Project cage site will be located at Providence, Mahé as indicated in Figure 2 below.

**Research and Development (R&D) Facility:**

The Seychelles R&D Facility at Anse Royale, Mahé will be a multi-species tropical fish hatchery, science hub and visitors centre. The facility aims to provide technical support, research, and training to develop and advance the Seychelles aquaculture sector while promoting public awareness and enthusiasm for this new sector.

The R&D Facility is located 8 km from the Mahé International Airport, and 18 km from the capital Victoria. The site is on the southern grounds of the University of Seychelles (UNISEY) and is easily accessible and well serviced by road networks. The area has a very gentle slope and is situated next to an artificial canal. The canal leads under the East Coast Road, into the sea, offering good access for water supply and waste discharge pipes from the facility into the sea with minimal environmental or aesthetic impacts (Figure 3 and Figure 4).

The facility has two distinct components: the “inland” area adjacent to the University of Seychelles where the R&D centre is proposed to be situated, and the “beach” area 200 m east, adjacent to the SFA ice plant. The beach site links the R&D centre to the sea and the Pilot Project cage operation at Providence, which will be developed and operate in conjunction with the R&D Facility.

As part of the R&D Facility, the water storage reservoir and water abstraction and discharge pipe will be assessed for impact. The R&D Facility cannot function without a constant supply of water.


*Figure 1: Pilot Project, BAQF and R&D Facilities located on Mahé*


*Figure 2: Broodstock Acclimation and Quarantine Facility (BQAF) and Pilot Project Cage Site at Providence Harbour*


*Figure 3: Location of the R&D Facility (land based and beach site and water abstraction pipe) at UNISEY, Anse Royale*

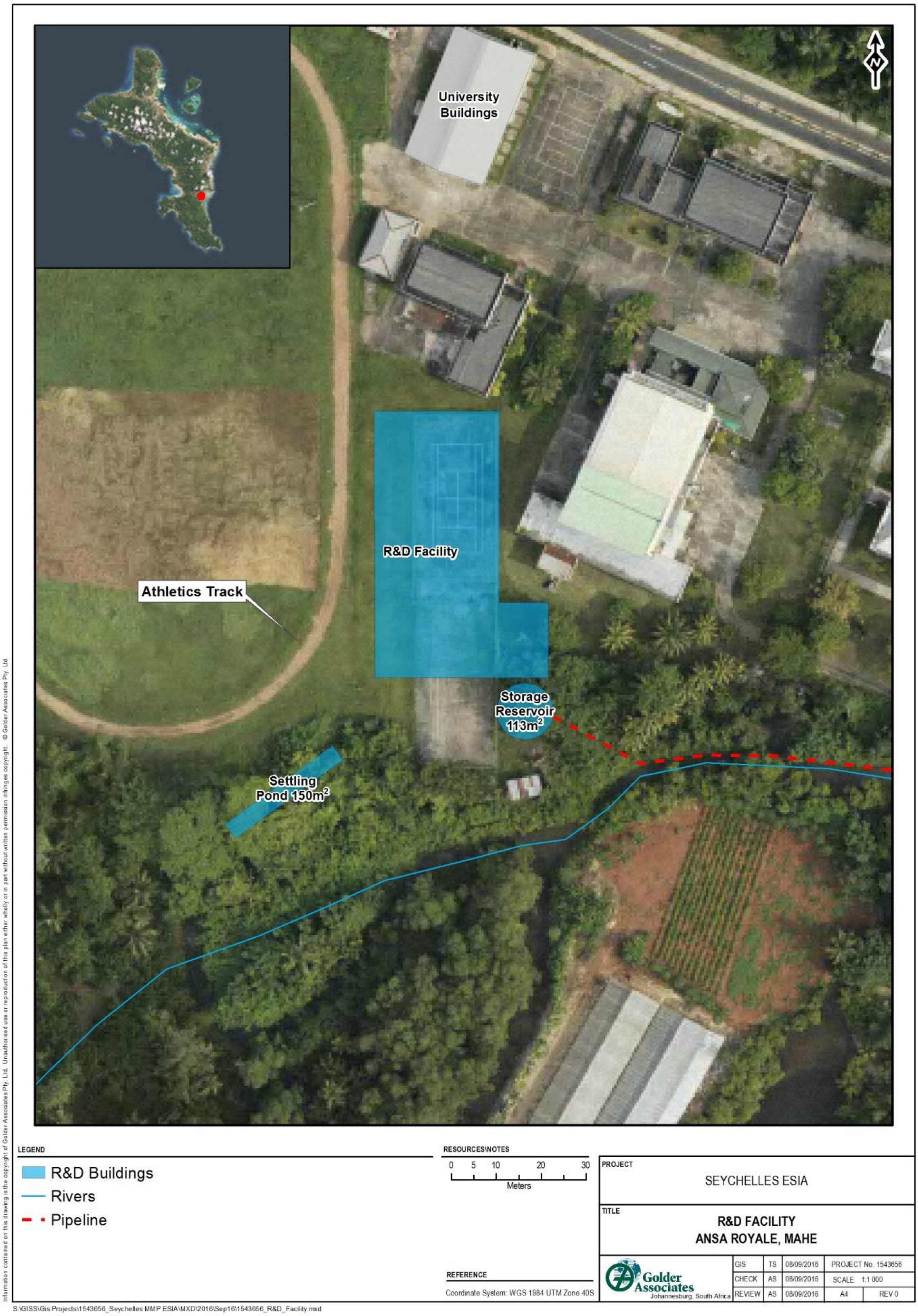



*Figure 4: The land based components of the R&D Facility*

### 1.2.2 Aquaculture Development Zones (ADZs)

Aquaculture Development Zones (ADZs) refer to identified finfish cage culture zones as part of the MMP. Individual fish farms with floating cages will operate inside ADZs. These cages will be serviced daily from land and will be located at a distance greater than 2 km from land (the 2 km distance from shore criterion was applied only where the shore (in direct line of sight) was inhabited. The site selection criteria is discussed further in the main ESIA Report). In-depth analysis and research has been undertaken in order to select each ADZ based on environmental and ecological criteria. The following finfish species could be successfully cultivated in the ADZs using cage culture:

- Brown-marbled grouper (*Epinephelus fucoguttatus*);
- Mangrove river snapper (*Lutjanus argentimaculatus*);
- Snubnose pompano (*Trachinotus blochii*);
- Emperor snapper (*Lutjanus sebae*); and
- Other target species identified as part of the MMP.

The proposed ADZs are shown in Figure 5 below.

The 12 zones provide a total of 53.2 km$^2$ for the initial development of the sector. Eight of the 12 sites are relatively well sheltered from the SE Monsoon, one is partly sheltered and three are not protected.

**Tier 1 Sites**

For purposes of the ESIA, the following sites were selected as Tier 1 sites (as shown in Figure 5):

- Site M 2;
- Site M 3;
- Site M 5; and
- Site PLD 2.

These sites are supported by the fact that extensive areas which have already been approved by an ESIA for sand extraction, occur over Sites M2, M3 and M5. Site PLD 2 was selected as it is sufficiently screened by Curieuse Island and offers developers who wish to base themselves at Praslin and/or La Digue the opportunity to access an ADZ which is nearby, and therefore logistically viable as these farms will be serviced from land. Tier 1 sites should ideally be developed over the first 10 years of the new aquaculture sector, where after operators may access Tier 2 sites.

Furthermore, due to the existence of the vast sand extraction areas, which are already pre-approved for this activity, the ADZs that occur over this area may expand in size or move in location across this area owing to the fact that the area will be disturbed by sand extraction activities. By having these activities occur together with aquaculture operations, an ongoing environmental monitoring programme can be implemented for these areas.

**Tier 2 sites**

The remainder of the 12 ADZs will therefore be classed as Tier 2 sites for the purpose of the ESIA (as shown in Figure 5):

- Site M 1;
- Site M 4;
- Site PLD 1;
- Site PLD 3;

- Site PLD 4;
- Site PLD 5;
- Site SN 1; and
- Site SN 2.

A proposed precautionary limit of 1000 tpa/km$^2$ will be the benchmark upon which to start the sector in the Seychelles. This means that operators will apply for licenses to operate farms at 1000 tpa/km$^2$. Therefore, each ADZ may have a number of different operators farming, each with sufficient buffers between them. These and other conditions will be stipulated in the EMP at the conclusion of this ESIA. This conservative start will mitigate uncertainty until such time as there is empirical data available from monitoring programmes upon which to go forward with greater certitude.

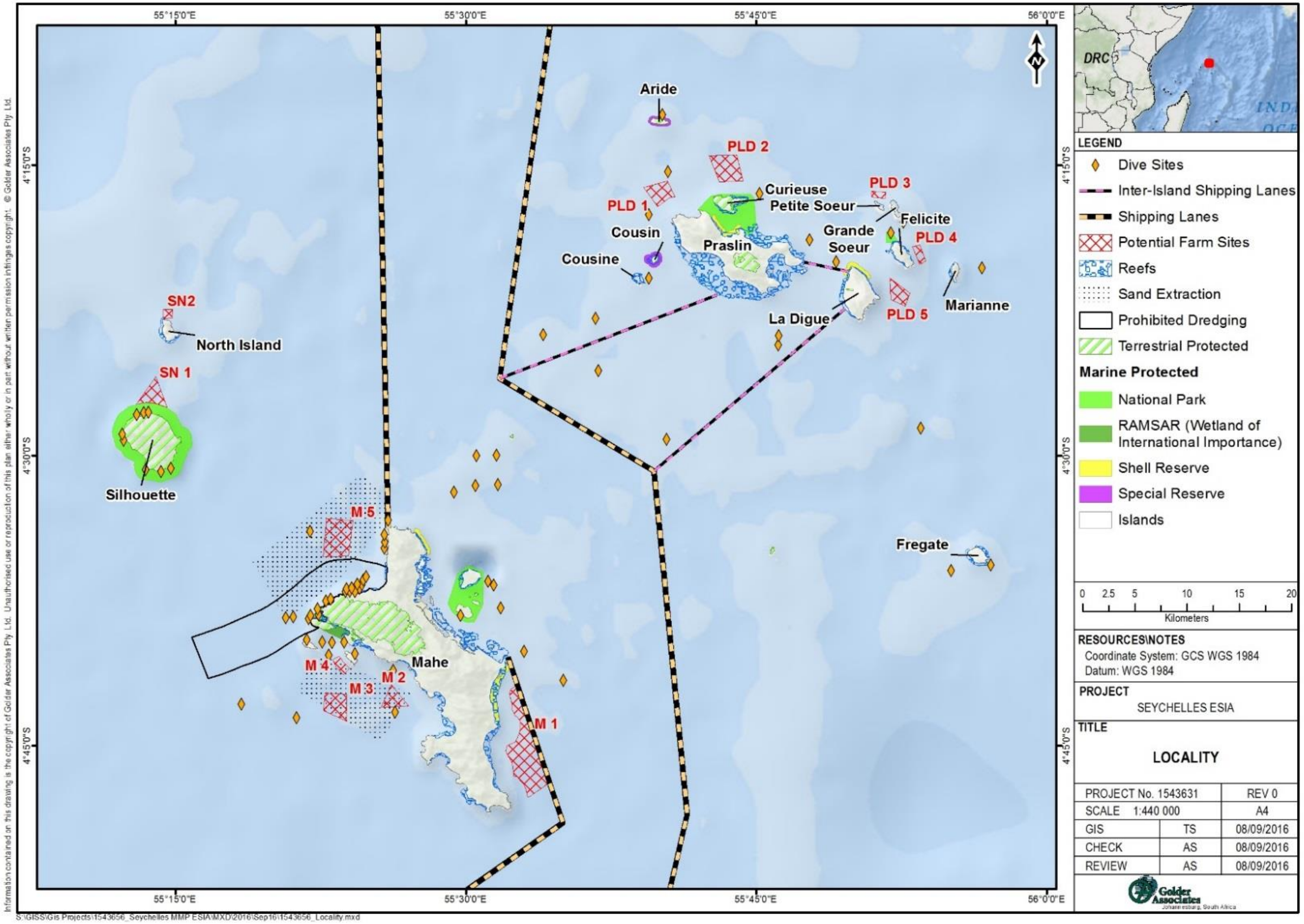



*Figure 5: Locality of proposed ADZs*

### 1.2.3 Proposed Cages and Technology for ADZs

Due to the fact that the MMP is guiding the development of a new aquaculture sector, where individual investors and farm operators are yet unknown, it should be kept in mind that their preferred cages, technology and other support infrastructure are also unknown at this time. The below section therefore attempts to give the reader more insight into what typical cages, and technology can be expected to be used by such investors and operators of individual farms. Images and descriptions have been taken from the AKVA Group website, and more information can be accessed directly from their website (http://www.akvagroup.com/home).

**Background**

Despite the fact that large-scale offshore aquaculture production only began globally in the early 1970's, there has been a rapid development of the technological solutions required to support farming in remote areas and under a wide range of environmental conditions. Across a range of factors, the Seychelles is characterised by moderate sea conditions and adequate technology exists to efficiently support the envisaged operations. Key to correctly specifying the various equipment components for the MMP is ensuring that a 'technological fit' is achieved where site conditions, species, scale, skill-sets, market requirements and investment capital are effectively aligned to create an efficient production unit.

**Cage Site Characterisation**

In the ADZ areas the nominated grow-out sites are characterised as 'moderate' by international standards (per the table below) allowing a wide range of technological solutions to be successfully applied.

**Table 1: Parameters influencing cage selection**

| ENVIRONMENTAL FACTOR | UNIT | TYPCIAL SITE VALUE | COMMENT |
|---|---|---|---|
| Significant wave height | Meters (m) | 1.6 | Small in comparison to other offshore cage sites |
| Maximum wave height | Meters (m) | 2.33 | Small in comparison to other offshore cage sites |
| Current speed | Meters per second (m/s) | Min=0.19,Max = 0.32, Mean = 0.19 | Ideal |
| Wind speed | Meters per second (m/s) | SE Monsoon (Mean= 7.33)<br>NW Monsoon = 3.18 | Wind is consistent and only increases to above gale force for short periods normally less than 1 hour |
| Depth | Meters (m) | 25-40m | Ideal |
| Seabed | | Course sand | Ideal for waste assimilation |
| Water temperature | ° C | 5m (24.8, Max = 30.5, Mean = 27.7) | |
| Oxygen | mg/L | 5m(Min=4.42, Max = 5, Mean = 4.73 | Typical values for tropical waters |

**Cages**

Aquaculture cages offer numerous designs and configurations that can be applied to the wide range of environmental conditions associated with sites around the world. Based on the 'moderate' site characterisation a number of different cage types could be successfully selected for application in the Seychelles ADZ's; in particular, either square steel cages or circular High-Density Polyethylene (HDPE) cages could be used. Steel cages provide easy access, a stable and safe working platform and are well suited to hand-feeding operations. Circular HDPE cages are best suited for rough sea conditions and are the most adaptable cage solution. For the purposes of the economic model Circular HDPE cages with 100m circumference have been assumed as detailed in the table below. Since individual licenses will be allocated on a 1,000tpa basis, the typical specifications for a 1,000tpa production unit is presented below.

**Table 2: Typical cage specifications**

| **Cage Specification per 1,000tpa unit** | | |
|---|---|---|
| **Component** | **Detail** | |
| Cage number | Cages per unit | 12 |
| Cage type | Polarcirkel | High-density polyethylene (HDPE) |
| Cage size | Circumference | 100m |
| Cage size | Diameter | 32m |
| Floating pipes | Pipe diameter | 315mm |
| Net depth | Depth of net in water | 5m (+1.3) |
| Cage volume | Volume in water | 4,019m³ |
| Mooring system | Anchors | - |

*Figure 6: Typical Cage Structure*

**Nets**

The Seychelles sites experience minimal seasonal bio-fouling and therefore regular nylon nets can be used, impregnated with standard anti-fouling coatings. Net depth is important and will be determined by both the site and species – for the grouper species model an effective depth of 5m has been used i.e. 5m underwater and 1m above water.

**Table 3: Typical net configuration**

| Net Specification per 1,000tpa unit | | |
|---|---|---|
| **Component** | **Detail** | |
| Net number | Nets per unit | 14 |
| Net size | | 100mC x 5m Depth (+1.3m) |
| Net material | | Nylon |
| Net aperture | Full mesh size | (2x) 12mm<br>(12x) 28mm |

### Feeding Systems

An assortment of technologies can be applied to feeding fish in offshore cages. In the simplest form feeding is done by hand using scoops that are used to manually distribute feed pellets over the cage surface. Various types of equipment are available as a means of mechanising feeding operations and ultimately even a fully automated system could be used, such as represented in Figure 7.

*Figure 7: Example of an automated AKVA Feeding System*

### Boats and Barges

#### *Feed Barge*

The use of feed barges combining feed silos, feeding equipment, monitoring systems and living facilities are the commonly used approach to off-shore aquaculture. Barges are scalable with production requirements and it is possible that a 100 tonne unit would be used per 1,000tpa site, however this is more likely to occur for offshore sites (not covered under this ESIA).

Figure 8: Example of an AKVA Feed Barge

***Well-boat***

The transport of harvest size fish from the grow-out sites to the onshore processing facility is done by the use of a well-boat. In mature industries it is common that this service can be outsourced to a third party operator but based on the early stage nature of the industry in the Seychelles it is assumed that a well-boat would not be purchased by individual operators, however they may choose to combine and purchase one that services multiple operators and sites.

Figure 9: Example of a typical 220m$^3$ Well-boat

***Workboats***

A large workboat will typically be required for the delivery of feed to the cage sites and general operations. A second boat may be required for the transport of employees. It is anticipated that cage sites may have a workboat permanently moored to the cages for emergencies.

*Figure 10: Example of a smaller workboat*

**Hatchery and Nursery**

As already described in section 1.2, the hatchery, nursery and broodstock holding facility will all be housed on-shore. The R&D hatchery will use a partial Recirculating Aquaculture System (RAS), while the nursery and broodstock holding facilities will use a flow-through system similar to the one depicted below. Operators may in future wish to set up their facilities which may also follow the same configuration.

*Figure 11: Example of an AKVA RAS System*

**Processing Facility**

For the first few years of the new aquaculture sector, it is assumed that the existing tuna processing plants have adequate capacity to handle the processing and waste volumes associated with the ADZs. In future, new fish processing plants will need to be established to support the sector. Processing facilities were therefore not assessed in this study since processing facilities are already in existence. In future, should additional processing facilities be built, it is anticipated that these will be sited and built adjacent to the existing facilities at Victoria Port which is zoned for industrial land use.

### Summary of Project Infrastructure and Components

The following infrastructure and components form part of the proposed aquaculture sector being assessed in this ESIA:

- Floating cages (to be sited within various ADZs);
- Ancillary cage infrastructure (feed barges);
- Well boats and/or work boats;
- Broodstock Acclimation and Quarantine Facility (BQAF); and
- Research and Development (R&D) Facility.

This VIA will focus primarily on the floating cages to be sited within ADZs and related water based infrastructure in these areas. Due to the relatively small size and nature of the BQAF and R&D facilities, they have not been determined to be of any significance from a visual impact perspective. The BQAF will blend in with the existing buildings situated at Providence Harbour which are of an industrial nature, also with similar activities to those proposed as part of the operation of the BQAF. It is not anticipated that the BQAF will be in conflict with any sensitive receptor in the vicinity due to the area being an industrial/port node.

The pilot cage site is relatively small (200 tonnes), and will be situated off the breakwater at Providence Harbour. The site is not expected to conflict with any sensitive receptors as there are no tourism facilities nearby.

The R&D facility was decided to be sited at the University of Seychelles in order to match the existing educational/scientific land use associated with a university. The R&D building is expected to blend in with existing academic buildings and research activities will complement those already practised at the university. It is not anticipated that the R&D facility will be in conflict with any sensitive receptor in the vicinity.

Based on the above, the BQAF, R&D facility and pilot project cage site will not be assessed any further in this VIA as impacts arising from these components are expected to be **negligible**.

## 2.0 TERMS OF REFERENCE

The terms of reference for the VIA is to determine the potential visual impacts of the proposed project components on potential viewers or receptors, in terms of the visual context within which the activity will take place and, if feasible, to develop mitigation strategies to address these. In order to achieve this aim, the following steps were followed:

- Conduct a visual baseline investigation and subsequently characterise the visual resource value and quality of the ADZs and the surrounding study area;
- Identify potential visual receptors that may be adversely affected by the proposed aquaculture sector;
- Describe the change in the visual resource that would be brought about by key components of the proposed aquaculture sector and how visible this change will be from the surrounding areas;
- Quantify the expected visual impacts of the proposed aquaculture sector in terms of their magnitude and significance; and
- Recommend measures to reduce or mitigate the potential visual impacts caused by the proposed aquaculture sector.

# 3.0 ASSUMPTIONS AND LIMITATIONS

The following assumptions and qualifications are relevant specifically to the field of VIA and the findings of this study:

- Determining the value, quality and significance of a visual resource or the significance of the visual impact that any activity may have on it, in absolute terms, is not achievable. The value of a visual resource is partly determined by the viewer and is influenced by that person's socio-economic, cultural and specific family background and is even subject to fluctuating factors such as emotional mood. This situation is compounded by the fact that the conditions under which the visual resource is viewed can change dramatically due to natural phenomena such as weather, climatic conditions and seasonal change. Visual impact cannot therefore be measured simply and reliably, as is for instance the case with water, noise or air pollution. It is therefore impossible to conduct a visual assessment without relying to some extent on the expert professional opinion of a qualified consultant, which is inherently subjective. The subjective opinion of the visual consultant is however unlikely to materially influence the findings and recommendations of this study, as a wide body of scientific knowledge exists in the industry of visual impact assessment, on which findings are based;
- Due to the nature of the ADZs, within which individual fish farms will be established and operated, the findings of this report are of a general nature and proposed mitigation may need to be reviewed and updated when final fish farm positions and layouts have been produced for the actual project implementation. This study seeks to assess potential impact associated with likely fish farm operations within each ADZ;
- In the absence of detailed information regarding the heights of certain components of the project, a worst-case scenario was adopted whereby the greatest likely heights for these components were assumed for the purposes of conducting the viewshed analysis;
- The Digital Elevation Model (DEM) was developed for the entire area covering Mahé, Praslin, La Digue, Silhouette and North Islands. The DEM was developed from 10 m contour data for Mahé, Praslin and La Digue. The DEM was extrapolated for Silhouette and North Islands using ASTER GDEM Version 2. Viewsheds were generated for a 5km radius around individual ADZs; and
- By downloading the ASTER data we agree to acknowledge them as follows: The ASTER GDEM is concurrently distributed from the Ministry of Economy, Trade, and Industry (METI) Earth Remote Sensing Data Analysis Centre (ERSDAC) in Japan and the National Aeronautics and Space Administration (NASA) Earth Observing System (EOS) Data Information System (EOSDIS) Land Processes (LP) Distributed Active Archive Centre (DAAC) in the United States.

# 4.0 STUDY AREA FOR THE VIA

The study area for the VIA comprises the spatial extent of the project infrastructure footprint and related activities, as well as an associated buffer area. For purposes of this VIA, the area will be represented by the 12 ADZs.

A visual impact will be caused by all visible infrastructural components and activities that will take place as part of the project, as well as all areas where the physical appearance of the landscape or waterscape will be altered by project activities and infrastructure. In these areas, the existing surface area will be replaced or the environment will be physically altered and will therefore be visually directly impacted upon. In the case of floating cages, the effects are temporary.

For the purposes of this VIA, the study area was defined as a 5 km radius around each ADZ. The distance of 5 km was selected based on the fact that the human eye cannot distinguish significant detail beyond this range. In addition, for good visibility conditions, a person standing at the shoreline (at sea level) would typically see the horizon at approximately 5 km. For this reason, the visual impact beyond this range is considered negligible.

For the purposes of this VIA, the term "site" refers to the areas that will be physically affected by the proposed aquaculture activities and infrastructure. Similarly, the term "study area" refers to the area that will potentially be visually affected by the project and represents the 5 km radius buffer around the visible components of the ADZ (such as the floating cage or work boat).

# 5.0 METHODOLOGY

The VIA specialist study, for the purposes of this EIA, was conducted following the methodology summarised below (Figure 12):

- Describing the landscape character or visual baseline, based on the results of various site visits conducted by Golder staff during 2016 and a review of available aerial photography and topographical maps, in terms of:
  - Natural elements; and
  - Human-made elements.
- Determining the visual resource value of the landscape in terms of:
  - The character of the sites and their surroundings and potential occurrence of prominent features of interest;
  - The general nature and level of disturbance within the study area; and
  - The nature and level of human disturbance and transformation evident.
- Determine the visual absorption capacity of the receiving visual landscape;
- Determining the receptor sensitivity to the proposed project;
- Determine the magnitude of the impact, by considering the proposed project in terms of aspects of VIA, namely:
  - Visibility;
  - Visual intrusion; and
  - Visual exposure.
- Assessing the impact significance by relating the magnitude of the visual impact to its:
  - Duration;
  - Severity; and
  - Geographical extent.
- To recommend mitigation measures to reduce the potential visual impacts of the project.

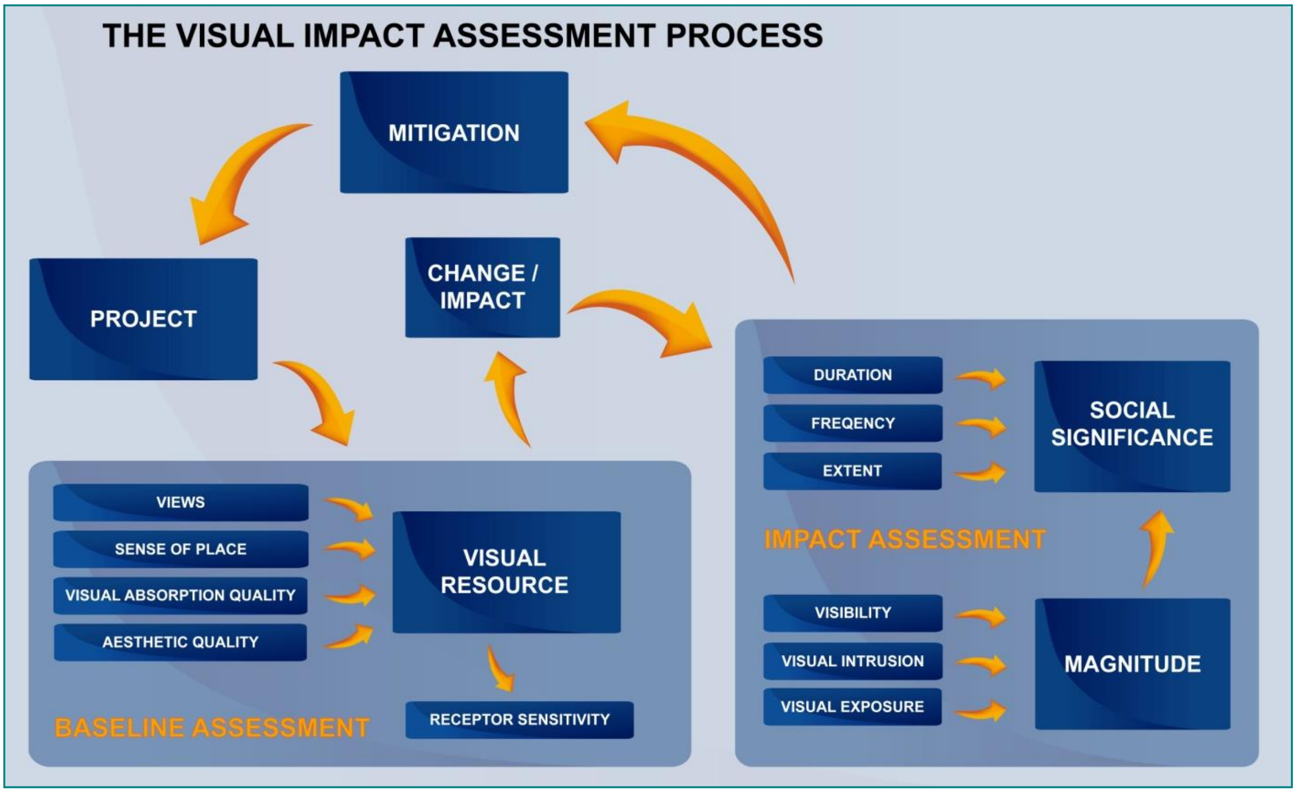



*Figure 12: Methodology to conduct a Visual Impact Assessment*

# 6.0 VISUAL BASELINE

The visual baseline is a description of the existing natural (physical and biological) and human-made (land/water use) attributes of the study area. This description is done primarily from an objective, visually orientated perspective and does not specifically address the underlying ecological or physical processes within the landscape. The visual resource value of the study area is then determined by assessing the visual baseline in terms of a number of industry-accepted concepts and criteria. Photographs of the site and study area are presented throughout this section, to illustrate certain arguments.

## 6.1 Study Area Visual Baseline

The regional area can be defined as the inner islands of the Seychelles, notably Mahé, Praslin, La Digue, Silhouette and North Islands which are the focal areas around which the 12 ADZs are situated. These islands which are granitic in nature and are remnants of past volcanic activity, are fully vegetated, mostly with secondary forest cover. The islands are mostly mountainous with peaks reaching up to 500-700 m (Mahé, Praslin and Silhouette) with lower peaks on North and La Digue reaching between 50-150 m above sea level.

The coastlines of these islands consist of long white sandy beaches, flat fringing reefs and rugged sea cliffs. Tourist establishments such as large hotels and other accommodation options are generally located in the areas which offer easy beach access. A number of smaller islands and rocky outcrops also occur along the coastlines of these main islands.

The climate is classified as humid tropical which, together with pristine beaches and warm waters is a popular tourist destination. The inner islands (as well as the rest of the Seychelles) can be described as having an extremely scenic visual character. Even the more urban and developed centres such as Victoria, Providence, Anse Royale, Beau Vallon, Baie Ste Anne (Praslin) and La Digue all still encapsulate the idyllic island setting of their surrounds. The waters between the main islands are frequented by commercial ships, ferry passenger ships/boats, industrial fishing, semi-industrial fishing and artisanal fishing boats, recreational fishing and dive boats.

*Figure 13: View from Providence Harbour looking north-west. The mountainous landscape dominates even in the semi-industrial area*

*Figure 14: View of main beach at Anse Royale near to the R&D facility*

*Figure 15: View across L'Ilette with Therese to the left*

*Figure 16: View from offshore looking towards Beau Vallon, Mahé*

*Figure 17: View of main beach at Beau Vallon*

*Figure 18: View from Anse Lazio beach, Praslin towards ADZ PLD1*

## 6.2 Study Area Visual Resource Value

Visual resource value refers to the visual quality of elements of an environment, as well as the way in which combinations of elements in an environment appeal to our senses. Studies in perceptual psychology have shown an affinity for landscapes with a higher visual complexity, rather than homogeneous ones (NLA, 2004). Furthermore, based on research in terms of human visual preference (Crawford, 1994), landscape quality increases when:

- Prominent topographical features and rugged horizon lines exist;
- Water bodies such as the ocean, rivers, streams or lakes are present;
- Untransformed indigenous vegetation cover dominates; and
- Limited presence of human activity, or land/water uses that are not visually intrusive or dominant prevail.

Further to these factors, Table 4 indicates criteria used for visual resource assessment. The assessment combines visual quality attributes (views, sense of place and aesthetic appeal) with landscape character and gives the landscape a high, moderate or low visual resource value.

When assessing the value of a landscape as visual resource, it is also necessary to consider the landscape in the context where it is located. Although a specific landscape may be less impressive than others located far off or in other countries, it may still be considered appealing because of its specific attributes compared to other landscapes nearby. In this way, what may be commonplace when placed in another visual context may be special or exceptional when viewed within its present setting.

**Table 4: Visual resource value criteria**

| Visual Resource Value | Criteria |
|---|---|
| **High (3)** | Pristine or near-pristine condition / natural areas with little to no visible human intervention visible / characterised by highly scenic or attractive natural features, or cultural heritage sites with high historical or social value and visual appeal / Areas that exhibit a strong positive character with valued features that combine to give the experience of unity, richness and harmony. These are landscapes that may be considered to be of particular importance to conserve and which may be sensitive to change. |
| **Moderate (2)** | Partially transformed or disturbed landscape / human intervention visible but does not dominate view / scenic appeal of landscape partially compromised / noticeable presence of incongruous elements / Areas that exhibit positive character but which may have evidence of degradation / erosion of some features resulting in areas of more mixed character. These landscapes are less important to conserve, but may include certain areas or features worthy of conservation. |
| **Low (1)** | Extensively transformed or disturbed landscape / human intervention dominates available views / scenic appeal of landscape greatly compromised / visual prominence of widely disparate or incongruous land uses and activities / Areas generally negative in character with few, if any, valued features. Scope for positive enhancement frequently occurs. |

### 6.2.1 Visual Resource Value Summary

Based on the results of the local visual baseline assessment and taking the factors tabulated above into consideration, the following conclusions regarding the visual resource value of the study area are made, and summarised in Table 5 below:

- The topography of the study area around each ADZ is characteristic of the Seychelles inner islands in that large mountains rise quickly from behind the coastline. This backdrop is visually appealing and also affords long uninterrupted views out to sea from these elevated areas. It is therefore deemed to be visually distinct or characterised by unique features. Hence, the visual resource value of the study area's topography is rated as being high (3);
- As with the topography, the hydrological character of the study area is typical of a tropical coastline. The white sands or rugged cliffs of the coastline contribute to the appeal of the area, more so as these are also important faunal habitat areas for terrestrial and marine species. Hence, the visual resource value of the ocean water bodies in the study area are rated as making a high (3) contribution to the visual resource value of the study area;
- The study area vegetation cover has been extensively transformed by logging in the past, however secondary growth of the forest cover is still highly appealing. In addition, coastal palm trees line the shoreline, especially near beaches which adds to the resource value and visually distinct and therefore also deemed to be of significance. Hence, the vegetation cover of the study area is rated to be of high (3) visual resource value; and
- Land use within the study area is of a low intensity and mostly semi-urban or natural. The pristine beaches and attractive coastline, clear ocean water, scenic views, clean air and limited presence of man-made elements are all strong drawing cards of the entire region and hence the land use component within the study area is rated as being of high (3) visual resource value.

**Table 5: Visual resource value determination**

| Visual baseline attribute | Topography | Water bodies | Vegetation | Land uses |
|---|---|---|---|---|
| **Visual resource value score** | 3 (high) | 3 (high) | 3 (high) | 3 (high) |
| **Total** | | | | **12 (high)** |

Where:

- 4-6=Low;
- 7-9=Moderate; and
- 10-12=High.

Based on the above score ranges, the overall visual resource value of the study area (12) is rated as **high**.

## 6.3 Visual Absorption Capacity

Visual absorption capacity (VAC) can be defined as "an estimation of the capacity of the landscape to absorb development without creating a significant change in visual character or producing a reduction in scenic quality" (Oberholzer, 2005). The ability of a landscape to absorb development or additional human intervention is primarily determined by the nature and occurrence of vegetation cover, topographical character and human structures or activity.

A further major factor is the degree of visual contrast between the proposed new project and the existing elements in the landscape. If, for example, a visually prominent industrial development already exists in an area, the capacity of that section of landscape to visually "absorb" additional industrial structures is higher than that of a similar section of landscape that is still in its natural state. VAC is therefore primarily a function of the existing land use and cover, in combination with the topographical ruggedness or seascape of the study area and immediate surroundings.

Based on the flat nature of the tropical waters in the inner islands, visually homogenous vegetation cover of surrounding mountains and low levels of development and landscape transformation, the VAC of the study area is rated as being **low**.

### 6.3.1 Visual Absorption Capacity Weighting Factor

In order to account for the fact that visual impacts are expected to be more intrusive in landscapes with a lower VAC than in those with a higher VAC (regardless of the visual quality of the landscape), a weighting factor is incorporated into the impact magnitude determination, as indicated in Table 6:

**Table 6: Visual absorption capacity weighting factor table**

| Visual resource value of receiving landscape | Low VAC | Medium VAC | High VAC |
|---|---|---|---|
| High resource value | High (1.2) | High (1.2) | Moderate (1.0) |
| Medium resource value | High (1.2) | Moderate (1.0) | Low (0.8) |
| Low visual resource value | Moderate (1.0) | Low (0.8) | Low (0.8) |

The visual resource value of the study area has been determined to be high (Section 6.2.1), whilst the VAC of the study area has been rated as low (Section 6.3). Hence, a high (1.2) weighting factor in terms of VAC is applied during the impact assessment.

## 6.4 Visual Receptor Sensitivity

### 6.4.1 Receptor Groups

Potential viewers, or visual receptors, are people that might see the proposed development (ADZs), as visual impact is primarily an impact concerned with human interest. Receptor sensitivity refers to the degree to which an activity will actually impact on receptors and depends on how many persons see the project or activities, how frequently they are exposed to it and their perceptions regarding aesthetics. Receptors of the proposed aquaculture sector development can be broadly categorised into two main groups, namely:

- People who live or work in the area and who will frequently be exposed to the project components (resident receptors); and
- People who travel through the area (tourists), and are only temporarily exposed to the project components (transient receptors).

As can be seen in Figure 19, there is a good mix between “Residential” and “Hotel & Tourism” land use classes throughout the inner islands which represent a mix of the two receptors.

### 6.4.2 Receptor Sensitivity and Incidence

The visual receptor sensitivity and incidence can be classified as high, moderate or low, as shown in Table 7.

**Table 7: Visual receptor sensitivity criteria**

| Number of people that will see the project (incidence factor): | |
|---|---|
| Large | Towns and cities, along major national roads (e.g. thousands of people) |
| Moderate | Villages, typically less than 1000 people |
| Small | Less than 100 people (e.g. a few households) |
| **Receptor perceived landscape value (sensitivity factor):** | |

| | |
|---|---|
| High | People attach a high value to aesthetics, such as in or around a nature reserve or conservation area, and the project is perceived to impact significantly on this value of the landscape. |
| Moderate | People attach a moderate value to aesthetics, such as smaller towns, where natural character is still plentiful and in close range of residency. |
| Low | People attach a low value to aesthetics, when compared to employment opportunities or commercial interests, for instance. Environments have already been transformed, such as cities and towns. |

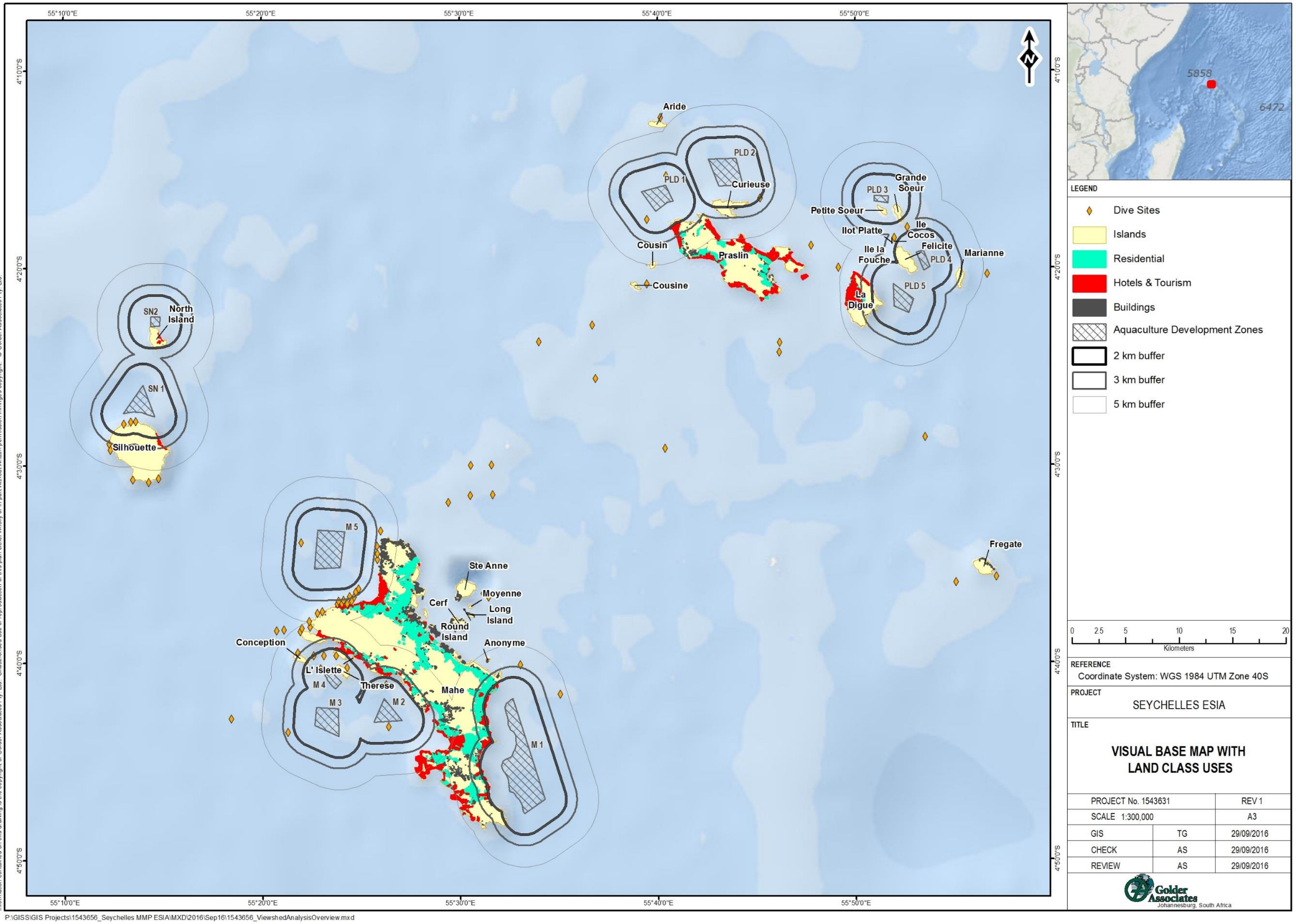



*Figure 19: Visual Receptor Base Map indicating Land Use Classes*

The following ratings have therefore been applied to the identified visual receptor groups:

- **Resident receptors**: Resident receptors comprise a moderate number of people (incidence factor) living in a region close to ADZs. This group of people is expected to attach moderate to high value (sensitivity factor) to the project and is therefore given a moderate sensitivity rating; and
- **Transient receptors**: It is expected that the majority of people that travel in/through the study area are residents and that a comparatively smaller number of persons tourists who are visiting the area. Accordingly, they constitute a moderate number of people (incidence factor). However, as the vicinity in which the sites are located is still mostly in a natural/pristine state, it is likely that most of the travellers (tourists) will attach a high degree of value to the untransformed visual setting of the proposed project (sensitivity factor). Hence, this receptor group has also been given a moderate sensitivity rating.

Based on the above, a moderate number of people (incidence factor) are expected to be visually affected by the project and the overall perceived landscape value (sensitivity factor) will be high.

### 6.4.3 Receptor Sensitivity Weighting Factor

To determine the magnitude of a visual impact, a weighting factor that accounts for receptor sensitivity is determined (Table 8), based on the number of people that are likely to be exposed to a visual impact (incidence factor) and their expected perception of the value of the visual landscape and project impact (sensitivity factor).

**Table 8: Weighting factor for receptor sensitivity criteria**

| **Receptor Sensitivity** | | **Number of people that will see the project (incidence factor):** | | |
|---|---|---|---|---|
| | | Large | Moderate | Small |
| **Receptor perceived landscape value (sensitivity factor)** | High | High (1.2) | High (1.2) | Moderate (1.0) |
| | Moderate | High (1.2) | Moderate (1.0) | Low (0.8) |
| | Low | Moderate (1.0) | Low (0.8) | Low (0.8) |

Based on the receptor sensitivity assessment (Section 6.4.2) and the above criteria, a **high** weighting factor (1.2) in terms of this aspect is applied during the impact magnitude determination.

# 7.0 IMPACT ASSESSMENT

## 7.1 Impact Identification

The following potential visual impacts that may occur during the construction, operational and decommissioning phases of the proposed aquaculture sector development have been identified.

### 7.1.1 Construction Phases

- Reduction in visual resource value due to presence of construction related ships/boats bringing infrastructure and materials;
- Reduction in visual resource value due to increased shipping/boat traffic; and
- Light pollution at night.

### 7.1.2 Operational Phase

- Reduction in visual resource value due to presence of floating cages;

- Reduction in visual resource value due to presence of infrastructure such as feed barge or large well boats moored at cage sites;
- Reduction in visual resource value due to increased shipping/boat traffic bringing feed and supplies and harvesting fish; and
- Light pollution at night.

### 7.1.3 Decommissioning Phase

- Reduction in visual resource value due to presence of decommissioning related ships/boats dismantling and removing cages and infrastructure components; and
- Reinstatement of visual resource value due to dismantling and removal of floating cages and associated infrastructure.

### 7.1.4 Cumulative impacts

- Cumulative degradation of visual resource value as a result of multiple fish farms starting operations within the same ADZ; and
- Cumulative regional light pollution associated with multiple fish farms within an ADZ.

## 7.2 Impact Magnitude Criteria

The magnitude of a visual impact is determined by considering the visual resource value and VAC of the landscape within which the project or activities will take place, the receptors potentially affected by it, together with the level of visibility of the project components, their degree of visual intrusion and the potential visual exposure of receptors to the project, as further elaborated on below.

### 7.2.1 Theoretical Visibility

The level of theoretical visibility (LTV) is defined as the sections of the study area from which the proposed project or its constituent elements may be visible. This area was determined by conducting a viewshed analysis and using Geographic Information System (GIS) software with three-dimensional topographical modelling capabilities, including viewshed and line-of-sight analyses (cross-sections). The footprint of the proposed ADZs were mapped on a suitable base map and a digital elevation model (DEM) for the islands was created (Figure 21, Figure 22 and Figure 23). A viewshed analysis was then conducted from each ADZ outwards at distances of:

- <2 km from ADZs;
- 2 - 3 km from ADZs; and
- 3 - 5 km from ADZs.

These visibility contours (viewshed) were then superimposed on the DEM, creating areas on the islands which can be classed as having either a negligible, low, medium, medium-high or high visibility rating in the proximity to the ADZs. It should be noted that this exercise is theoretical and based on a direct line of sight. It does not account for dense vegetation along the coastline, which does screen receptors to a certain degree. It should further be noted that this exercise assumes a continuous sensitive receptor along the coastline for each ADZ viewshed, which is not the case. The visual receptor base map, aerial imagery and land use class data was then used to normalise the evaluation by reviewing the extent of sensitive receptors along a particular section of coastline concerning each ADZ viewshed. In this fashion, the LTV based on the results of the viewshed analysis was then rated as shown in the below table:

**Table 9: Level of visibility rating for each ADZ**

| ADZ Number | Visibility rating (theoretical) | Visibility rating (normalised) | Commentary |
|---|---|---|---|
| M1 | High | Medium | The coastline adjacent to ADZ M1 is heavily populated with locals and tourist establishments. The ADZ is located approximately 1.8km from the shoreline, hence the visibility rating has been scored at medium. |
| M2 | Low-Medium | Low | The ADZ is located further than 2kms from the shoreline, which is sparsely populated with mainly local dwellings and few tourist establishments. |
| M3 | Negligible | Negligible | The ADZ is located more than 4.5 km from shoreline. |
| M4 | Medium-High | Low | The ADZ is located between 1.5 km and 2.7 km form the shoreline, however it is screened by the uninhabited Therese Island from any receptors on Mahé Island. |
| M5 | Low | Low | The ADZ is located 3.5 km off the coast of Beau Vallon and Bel Ombre, which are large villages and popular tourist destinations with large Hotels along the coastline. The ADZ is sufficiently far offshore that the visibility rating has been scored as low. |
| PLD1 | Medium-High | Medium | No hotels present, although visitors to Anse Georgette beach will have views towards ADZ of less than 2 km. |
| PLD2 | High | Low | No Hotels or other receptors reside on Curieuse Island. The island is however a National Park and an MPA does surround it. Day visitors are expected to be present at times. |
| PLD3 | Low | Low | No receptors reside on Petite Soeur. Receptors residing on Grande Soeur located on South-west and South-east sides of island. |
| PLD4 | Medium-High | High | Hotel receptors located on Felicite (approx. 10-40 m elevation) have direct views of the ADZ at a distance of 1.4 km. The north-west quadrant of the ADZ will be visible up to a distance of 2 km. |
| PLD5 | Medium-High | Low | There are no receptors located on the east coast of La Digue within 2 km of the ADZ. |
| SN1 | High | Medium | The hotel on Silhouette Island is located in the area shaded as medium on east side of island. South-east corner of ADZ visible at less than 2 km from beach/hotel. |
| SN2 | High | High | Hotel on North Island is located on North-east coast in area shaded as High. Views towards ADZ from beach/hotel are less than 1 km. |

Based on the results of the above analysis, the following conclusions regarding theoretical visibility of each ADZ for the various project phases were arrived at:

## Construction Phase Impacts

It is anticipated that the construction phase LTV rating associated with bringing in floating cages and associated infrastructure will be the same as the operational phase LTV for each ADZ. This will be similar for the operational phase shipping and boating traffic associated with bringing in daily supplies, feed and fish farm crews. Harvesting of fish from cages will occur frequently within each ADZ.

#### Operational Phase Impacts

The Operational phase LTV ratings reflected in Table 9 are applicable.

#### Decommissioning Phase Impacts

The decommissioning phase LTV ratings will be similar to the construction and operational phases, except once they are completed the level of visibility will return back to its pre-project conditions.

### 7.2.2 Visual Exposure

The visual impact of a development diminishes at an exponential rate as the distance between the observer and the object increases – refer to Figure 20. Relative humidity and fog in the area directly influence the effect. Increased humidity causes the air to appear greyer, diminishing detail. Thus, the impact at 1 000 m would be 25% of the impact as viewed from 500 m. At 2 000 m it would be 10% of the impact at 500 m. The inverse relationship of distance and visual impact is well recognised in visual analysis literature (Hull and Bishop, 1988) and was used as important criteria for this study.

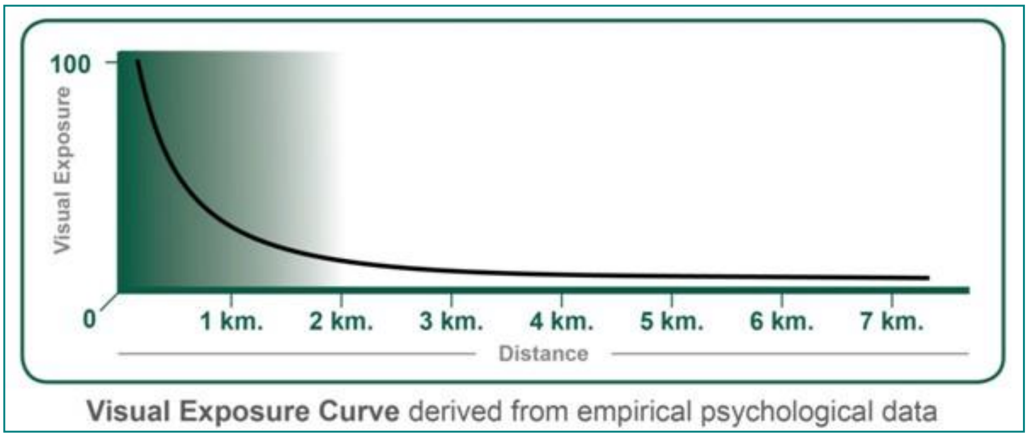


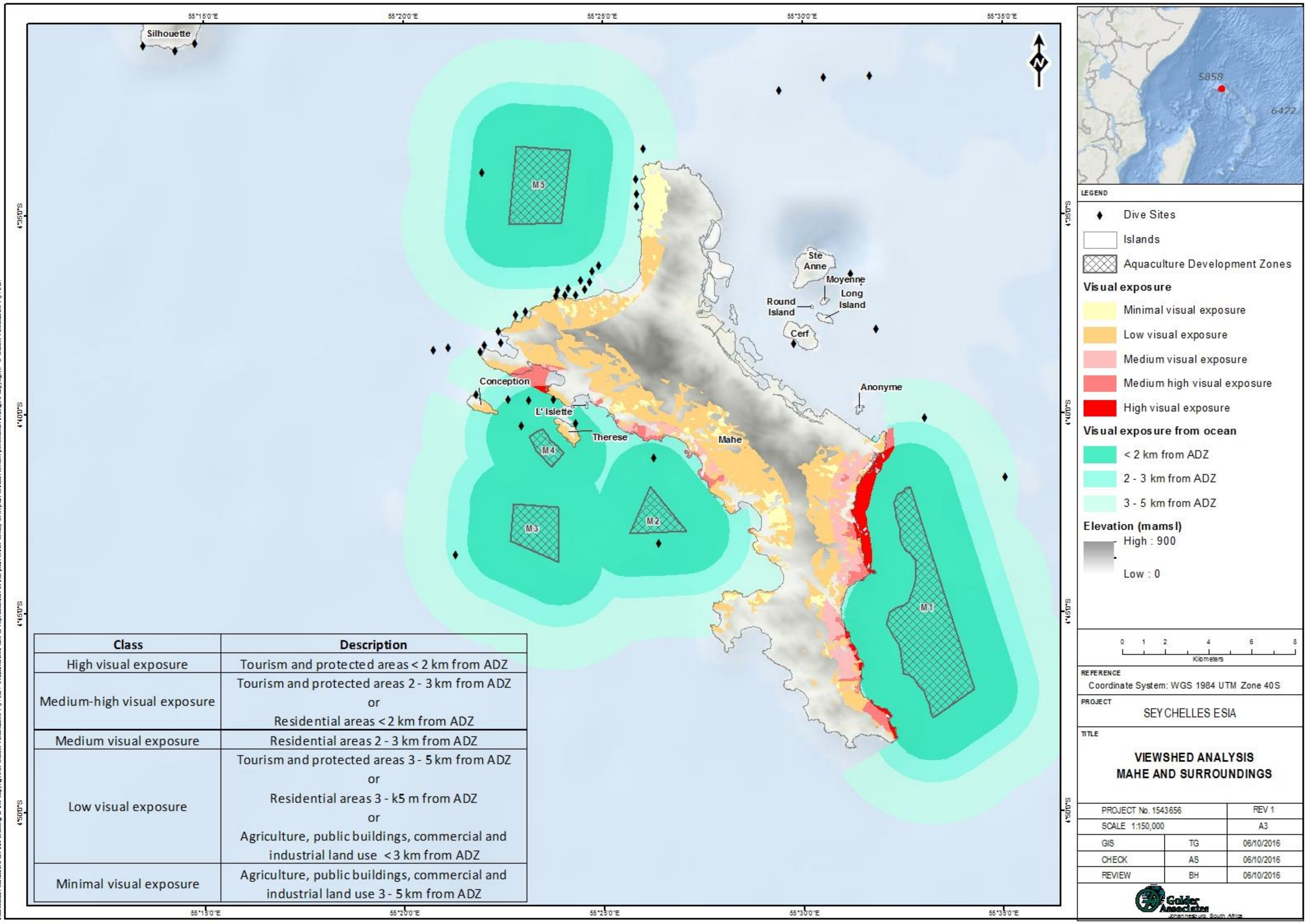

*Figure 20: Visual exposure graph*

Thus, visual exposure is an expression of how close receptors are expected to get to the proposed interventions on a regular basis. For the purposes of this assessment, close-range views (equating to a high level of visual exposure) are views over a distance of 2 km or less, medium-range views (equating to a moderate / medium level of visual exposure) are views of 2km to 3km, and long-range views are over distances greater than 3 km (low levels of visual exposure).

#### Construction, Operations and Decommissioning Phase Impacts

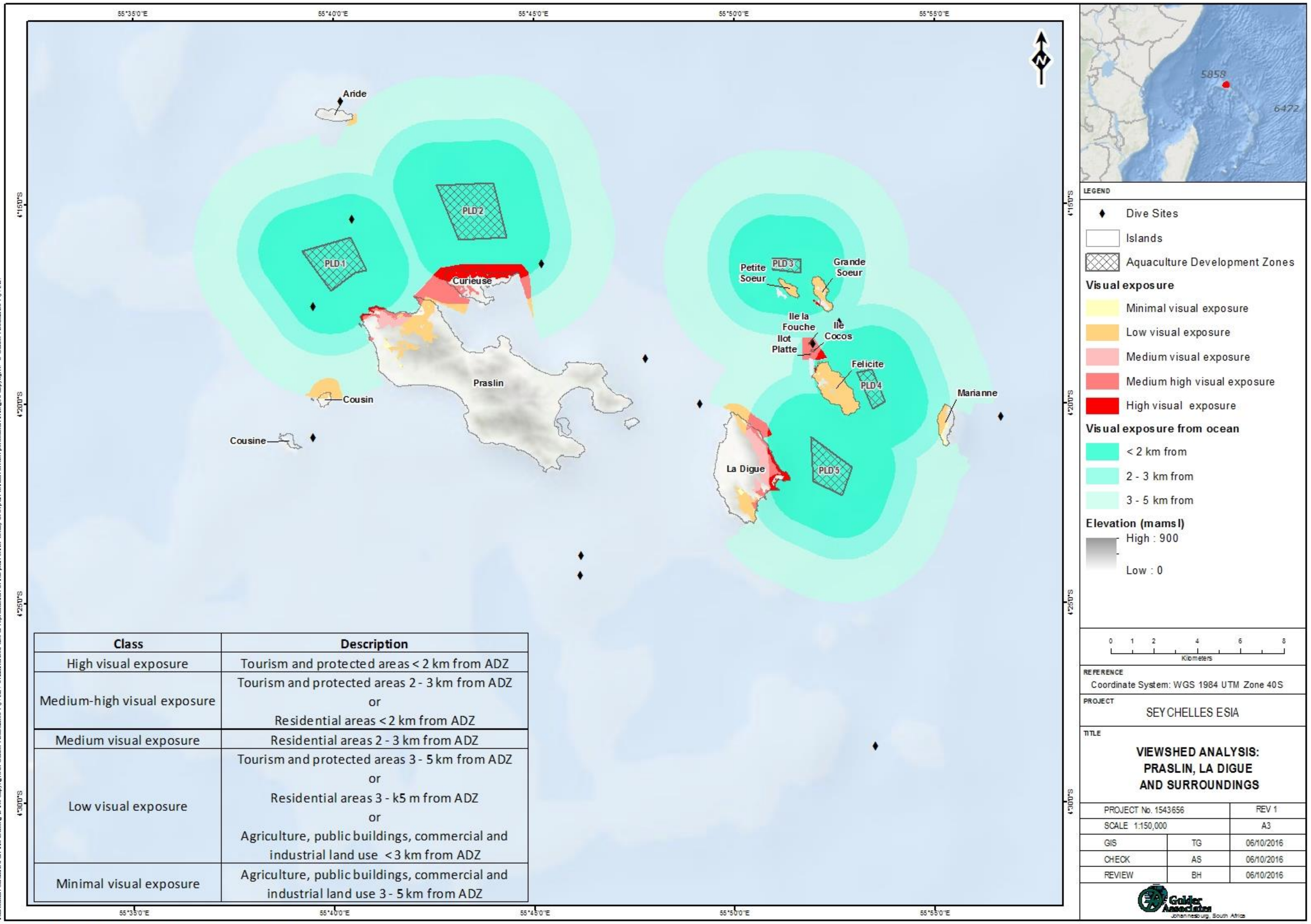
All identified impacts: There are no fixed receptors that will be exposed to the aquaculture activities at the ADZs within 500m from the shoreline. For the most part, ADZs are located at a distance of 2 kms form shore and in certain instances between 1.5km and 2 km which is sufficiently far not cause significant visual exposure. The ADZs of PLD4 and SN2 are located 1.4km and less than 1 km from receptors respectively. For the purposes of this assessment visual exposure in terms of all identified ADZs have therefore been rated as being low, except PLD4 and SN2 which are rated as moderate.

The ratings remain the same for construction, operations and decommissioning phases.




| Class | Description |
|---|---|
| High visual exposure | Tourism and protected areas < 2 km from ADZ |
| Medium-high visual exposure | Tourism and protected areas 2 - 3 km from ADZ or Residential areas < 2 km from ADZ |
| Medium visual exposure | Residential areas 2 - 3 km from ADZ |
| Low visual exposure | Tourism and protected areas 3 - 5 km from ADZ or Residential areas 3 - k5 m from ADZ or Agriculture, public buildings, commercial and industrial land use < 3 km from ADZ |
| Minimal visual exposure | Agriculture, public buildings, commercial and industrial land use 3 - 5 km from ADZ |

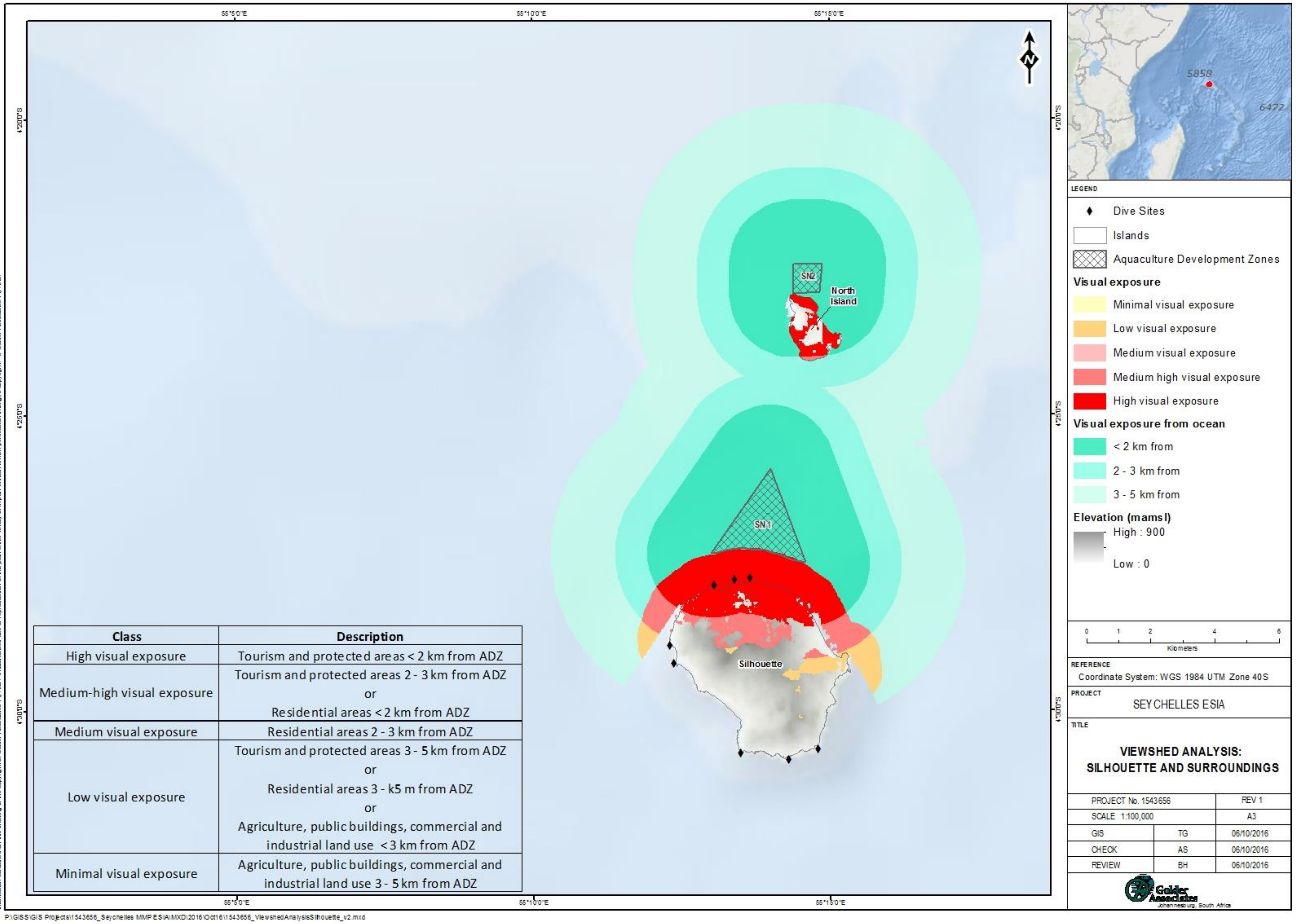
*Figure 21: Viewshed Analysis for Mahé ADZs*




| Class | Description |
|---|---|
| High visual exposure | Tourism and protected areas < 2 km from ADZ |
| Medium-high visual exposure | Tourism and protected areas 2 - 3 km from ADZ<br>or<br>Residential areas < 2 km from ADZ |
| Medium visual exposure | Residential areas 2 - 3 km from ADZ |
| Low visual exposure | Tourism and protected areas 3 - 5 km from ADZ<br>or<br>Residential areas 3 - k5 m from ADZ<br>or<br>Agriculture, public buildings, commercial and industrial land use < 3 km from ADZ |
| Minimal visual exposure | Agriculture, public buildings, commercial and industrial land use 3 - 5 km from ADZ |

P:\GISS\GIS Projects\1543656_Seychelles MMP ESIA\MXD\2016\Oct16\1543656_ViewshedAnalysisPraslin_v2.mxd

*Figure 22: Viewshed Analysis for Praslin and La Digue ADZs*




| Class | Description |
|---|---|
| High visual exposure | Tourism and protected areas < 2 km from ADZ |
| Medium-high visual exposure | Tourism and protected areas 2 - 3 km from ADZ or Residential areas < 2 km from ADZ |
| Medium visual exposure | Residential areas 2 - 3 km from ADZ |
| Low visual exposure | Tourism and protected areas 3 - 5 km from ADZ or Residential areas 3 - k5 m from ADZ or Agriculture, public buildings, commercial and industrial land use < 3 km from ADZ |
| Minimal visual exposure | Agriculture, public buildings, commercial and industrial land use 3 - 5 km from ADZ |

*Figure 23: Viewshed Analysis for Silhouette and North Island ADZs*

### 7.2.3 Visual Intrusion

Visual intrusion deals with how well the project components fit into the ecological and cultural aesthetic of the landscape as a whole. An object will have a greater negative impact on scenes considered to have a high visual quality than on scenes of low quality because the most scenic areas have the "most to lose".

The visual impact of a proposed landscape alteration also decreases as the complexity of the context within which it takes place, increases. If the existing visual context of the site is relatively simple and uniform any alterations or the addition of human-made elements tend to be very noticeable, whereas the same alterations in a visually complex and varied context do not attract as much attention. Especially as distance increases, the object becomes less of a focal point because there is more visual distraction, and the observer's attention is diverted by the complexity of the scene (Hull and Bishop, 1998).

The expected level of visual intrusion at each ADZ needs to be considered in the context of an individual fish farm being set-up and operated. Section 1.2.3 describes and illustrates typical fish farm infrastructure that are likely to be deployed in the ADZs, however individual fish farm operators may have their own preference compared to other operators. During farm establishment, the floating cages will be assembled and deployed into the water. These cages are typically only a 1m in height. Additional infrastructure such as a feed barge (only economical for large farms), may be up to 6-8 m in height. Work boats and well boats (ships) could be between 2 – 8m in height depending on the scale of operations. For the size of operators and fish farms expected in the ADZs, smaller work boats of 2-3 m in height are anticipated.

The floating cages are expected to be fairly non-intrusive due to their height, blend in well with the surrounding ocean waters (cages are typically dark hues such as greens and blues, with plastic components being black). Their shape could either be square units or a series of circular cages arranged in various configurations (typically cages are two-abreast and 6-8 in length). The floating cages will be moored with cables anchored to concrete blocks placed on the ocean floor. The mooring system will have mooring or marker buoys and possibly other navigational buoys which are highly visible and/or illuminated in order to warn water users of the submerged mooring system and presence of the fish farm in general. Marker buoys will be visible when one approaches the fish farm during daylight hours, whilst navigational lights are expected to be visible during the nigh time at greater distances. The effect of the navigational lights are expected to be similar to those of other boats anchored offshore during night time.

The presence of work boats and well boats associated with fish farms are not expected to be visually intrusive in the landscape since there are already a great number of water craft in the waters of the Seychelles. These boats and ships associated with leisure, passenger, cargo and sand mining activities are of a variety in size.

Feed barges associated with larger fish farms, may be more visually intrusive than work boats or well boats due to their size and form. The presence of feed pipes emerging from the barge and attached to cages, may also have the effect of being visually intrusive. That being said, at distances of greater than 2 km’s, it is thought that most receptors may have difficulty seeing any detail associated with the fish farms and distinguishing between leisure boats and boats associated with aquaculture activities.

Recreational boat users that may travel past fish farms may view them as being visually intrusive or they may have the effect of raising interest or curiosity. This has been demonstrated in other countries where aquaculture operations have been visited by tourists and school children as part of an educational tour.

Light pollution can be a highly objectionable night-time impact, especially in rural landscapes where development and activity do not occur yet. It is probable that the fish farms will always be staffed and that night time illumination will be required for various activities on board the floating cages. Hence, this impact has been rated as being potentially highly intrusive.

## 7.3 Impact Magnitude Methodology

The expected impact magnitude of the proposed project was rated, based on the above assessment of the visual resource value of the ADZs, as well as level of visibility, visual intrusion, visual exposure and receptor sensitivity as visual impact criteria. The process is summarised below.

***Magnitude = [(Visual quality of the site x VAC factor) x (Visibility + Visual Intrusion + Visual Exposure)] x Receptor sensitivity factor.***

*Thus*:

***[(1 x Factor 1.0) x (1 + 1 + 1)] x Factor 1 = 3***

From the above equation the maximum magnitude point (MP) score is 38.9 points.

The possible range of MP scores is then categorised as indicated in Table 10 below.

**Table 10: Impact magnitude point score range**

| MP Score | Magnitude rating |
|---|---|
| 20.1≤ | High |
| 13.1-20.0 | Moderate |
| 6.1-13.0 | Low |
| ≤6.0 | Negligible |

## 7.4 Impact Magnitude Determination

Based on the visual resource, VAC, receptor sensitivity and impact assessment criteria assessed in the preceding sections, the magnitude of the various impacts identified was determined for each component of the project, in this case for a typical fish farm operation. Consequently, the impact magnitude determination for the construction and operational phases and for the decommissioning phase is presented in Table 10 respectively.

Due to the similarity between the construction, operation and decommissioning activities, these have been grouped together and assessed collectively.

**Table 11: Construction, operation and decommissioning phases - impact magnitude summary**

| Visual impact | Study area visual resource value | VAC weighting factor | Level of visibility | Visual intrusion | Visual exposure | Receptor sensitivity factor | Impact magnitude point score |
|---|---|---|---|---|---|---|---|
| Reduction in visual resource value due to increased shipping/boat traffic (construction material and operational activities) | 3 | 1.2 | 3 | 1 | 1 | 1.2 | 21.6 (high) |
| Reduction in visual resource value due to presence of floating cages and associated infrastructure (feed barges and work/well boats) | 3 | 1.2 | 3 | 2 | 2 | 1.2 | 30.2 (high) |
| Light pollution at night (construction, operations and decommissioning) | 3 | 1.2 | 3 | 3 | 3 | 1.2 | 38.9 (high) |

(Where for: visual resource value, visibility, visual intrusion and visual exposure: high=3; moderate=2; low=1; and receptor sensitivity: high = factor 1.2; moderate = factor 1; low = factor 0.8.)

## 7.5 Impact Significance Rating Methodology

The significance of the identified impacts will be determined using the approach outlined below. The approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

| Occurrence | | Severity | |
|---|---|---|---|
| Probability of occurrence | Duration of occurrence | Scale / extent of impact | Magnitude (severity) of impact |

To assess each of these factors for each impact, the following four ranking scales are used:

| Magnitude | Duration |
|---|---|
| 10 - Very high/don't know | 5 - Permanent |
| 8 - High | 4 - Long-term (longer than 15 years, with impact ceasing after closure of the project) |
| 6 - Moderate | 3 - Medium-term (8-15 years) |
| 4 - Low | 2 - Short-term (0-7 years) |
| 2 - Minor | 1 – Immediate (less than a year) |
| **Scale** | **Probability** |
| 5 - International | 5 - Definite/don't know |
| 4 - National | 4 - Highly probable |
| 3 - Regional | 3 - Medium probability |
| 2 - Local | 2 - Low probability |
| 1 - Site only | 1 - Improbable |
| 0 - None | 0 - None |

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:

**SP (significance points) = (magnitude + duration + scale) x probability**

The maximum value is 100 significance points (SP). The impact significance will then be rated as follows:

| | | |
|---|---|---|
| **SP >75** | Indicates **high** environmental significance | An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation. |
| **SP 30 – 75** | Indicates **moderate** environmental significance | An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated. |
| **SP <30** | Indicates **low** environmental significance | Impacts with little real effect and which should not have an influence on or require modification of the project design. |
| **+** | Positive impact | An impact that is likely to result in positive consequences/effects. |

For the methodology outlined above, the following definitions were used:

- **Magnitude** is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely-recognised standards are to be used as a measure of the level of impact.

- **Scale/Geographic extent** refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international.
- **Duration** refers to the length of time over which an environmental impact may occur: i.e. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent.
- **Probability of occurrence** is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

## 7.6 Impact Significance Determination

Using the above criteria, the results of the impact significance assessment before and after mitigation, for the construction, operations and decommissioning phase impacts, are presented in Table 12. Due to the similarity between the construction, operation and decommissioning activities, these have been grouped together and assessed collectively. Consequently, mitigation measures for the various identified impacts are, where applicable, discussed in Section 8.0.

**Table 12: Impact significance determination for the construction, operation and decommissioning phase of the proposed ADZs**

| POTENTIAL ENVIRONMENTAL IMPACT | ENVIRONMENTAL SIGNIFICANCE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before mitigation | | | | | | After mitigation | | | | | |
| | M | D | S | P | SP | Rating | M | D | S | P | SP | Rating |
| Reduction in visual resource value due to increased shipping/boat traffic (construction material and operational activities) | 6 | 4 | 2 | 5 | 60 | Mod | 2 | 4 | 2 | 3 | 24 | Low |
| Reduction in visual resource value due to presence of floating cages and associated infrastructure (feed barges and work/well boats) | 6 | 4 | 2 | 5 | 60 | Mod | 2 | 4 | 2 | 3 | 24 | Low |
| Light pollution at night (construction, operations and decommissioning) | 6 | 4 | 2 | 5 | 60 | Mod | 4 | 4 | 2 | 3 | 30 | Mod |

Figure 24, Figure 25 and Figure 26 below provide modelled graphic representation of what a typical fish farm located approximately 2 km from the coastline would look like from three representative receptor locations, namely:

- From eye level along the beach;
- From a slightly elevated position (height of approximately 8 m) along the coastline; and
- From an elevated inland location (approximately 50m above sea level, 250 from the shoreline).

In all three instances, the influence of distance/reduced visual exposure on visual impact is clearly demonstrated, as the effective degree of visual intrusion of the proposed cage infrastructure is greatly diminished by the fact that most of the structure will not protrude above the visual horizon line. Furthermore, the cages which will be darkish in colour is masked to a notable extent by the colour of the sea water, which becomes darker over distance. Ancillary infrastructure such as a feed barge or storage/offices on the cage platform has been included in order to demonstrate a worse-case scenario, which still demonstrates the diminishing effect of visual intrusion over such distances.

The **magnitude of the visual impact is expected to be slightly higher from elevated viewpoints**, as a greater surface area of the cage is exposed due to the increased viewing angle. However, this factor will likely be offset or mitigated to some extent owing to the fact that the more elevated viewpoints/visual receptors are located farther away from the coastline and cages, therefore reducing the level of visual exposure.

It should be noted that these three views are only representative examples of a modelled view of a typical fish farm. The images were chosen as they also depict typical boat and larger vessels that occur in Seychelles waters. It should also be noted that there is relatively little difference in appearance between the fish farm cages and associated infrastructure when compared to typical boats associated with other users. Each modelled graphic also includes a zoomed insert of the modelled fish farm in order to give the reader an impression of what the fish farm looks like in appearance at closer distances.

*Figure 24: Modelled graphic representation of an example fish farm at a distance of 2km viewed from beach level*

*Figure 25: Modelled graphic representation of an example fish farm at a distance of 2km viewed from 8m above sea level*

*Figure 26: Modelled graphic representation of an example fish farm at a distance of 2km viewed from 50m above sea level*

### 7.6.1 Cumulative Impacts

The cumulative impact assessment case considers this project within the context of other similar fish farms being established within a particular ADZ or in an adjacent ADZ should there be one nearby. As previously stated in section 7.1.4, the below cumulative impacts are considered:

- Cumulative degradation of visual resource value as a result of multiple fish farms starting operations within the same ADZ; and
- Cumulative regional light pollution associated with multiple fish farms within an ADZ.

With multiple fish farms setting up operations within the same ADZ, there will be an enhanced degradation of the visual resource. By employing modern fish farming techniques that employ best practice guidelines, there should be adequate buffers in pace between each individual fish farm, including having a fallowing site for each active farming site. This should ensure that each ADZ is used efficiently, but also within the carrying capacity limits. By having adequate buffers between fish farms, this should have the effect of limiting the number of fish farms in a particular ADZ and therefore limiting the degradation of the visual resource.

The first fish farm sites within an ADZ should be utilised **at the furthest point away from the coastline**, which should have the added effect of further limiting the degradation of the visual resource and overall impact. However, with subsequent fish farms being set-up, these later farms will naturally take up sites which are closer to the shoreline (still within the ADZ), thereby increasing the cumulative impact and degradation of the visual resource.

The impacts assessed above, have however, taken the closest point of the ADZ to the shoreline and assessed this as the ‘worst-case’ scenario for purposes of this impact assessment.

## 8.0 MITIGATION AND MONITORING MEASURES

Visual mitigation of fish farms from sensitive receptors can be approached by the appropriate siting of fish farms within ADZs. If there are sensitive receptors which may have views to a portion of the ADZ at a short distance, e.g. less than 2 km’s which may lead to a degradation of the visual resource, then measures can be implemented by the controlling authority, in this case SFA, which stipulate where fish farms should be sited in the ADZ. They may also reduce the size of ADZs accordingly in order to exclude sensitive receptors direct line of sight of a portion of the ADZs and therefore fish farms within it.

Sites PLD4 and SN2 may require being reduced in order to limit sensitive receptors direct line of sight into these ADZs. Furthermore, consideration can be given to moving these ADZs slightly in order to limit the visual intrusion towards sensitive receptors, which in these two instances are high value tourism establishments.

In addition, management measures at individual fish farms can be implemented that limit the amount of lighting / illumination and/or the intensity of such lighting on board of the floating cages. For safety reasons, navigational lighting has specific standards that need to be implemented, however lighting for on-board crew can be adjusted to an absolute minimum required in order reduce any excess light pollution that may be visible form shore. Utilise security lighting (if feasible) that is movement activated rather than permanently switched on, to prevent unnecessary constant illumination. Avoid up-lighting of structures by rather directing lighting downwards and focused on the area to be illuminated.

Lastly, in order to reduce the visual intrusion that may be experienced by additional boat/shipping traffic, it is recommended that operators of fish farms try and schedule trips from main port to the fish farms at times of the day when receptors are least active. This may be during first light (early morning) or late afternoon before sunset. By scheduling boat and ship traffic, it may have the effect of reducing visual degradation experienced by sensitive receptors with views towards ADZs.

## 9.0 CONCLUSION

In summary, it can be stated that the study area is of high visual resource value and that the proposed project will impact negatively on the visual environment, specifically as the study area is largely rural/natural in character with semi-urban areas along the coastlines of the various islands. It should be noted that the negative impacts will be of a moderate to low significance.

The floating cages and associated infrastructure will have a low impact, whilst the presence of work boats/ships as well as lighting of cages at night may have a moderate impact on sensitive receptors located on shore. As a result, visual mitigation will be required during the various project phases.

Various visual mitigation measures have been identified to address the anticipated visual impacts, however it is expected that the mitigation potential will be limited to the siting of individual fish farms within the ADZs and reducing the size of ADZs where required (notably for sites PLD4 and SN2)

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# APPENDIX A

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## DOCUMENT LIMITATIONS

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