A study on sea condition of Seribu Islands, Jakarta and the potential of floating PV Systems.

R Hendarti

Architecture Department, Faculty of Engineering, Bina Nusantara University, Jakarta, Indonesia, 11480

Corresponding author: rhendarti@binus.ac.id

Abstract. This paper presents an initial study on the potential of the utilization of floating PV system for Seribu Island sea waters. Seribu Islands is an area consisting of many islands and there are many coral reefs and algae. From several existing studies, the condition of coral reefs and the algae, particularly the Zooxanthellae are quite alarming. This is not only because of human actions, but also because of the water's condition such as water temperature, salinity and pH. Additionally, the incoming light is also influence the growth of the algae. This paper, therefore, focus on study the sea condition particularly the condition of the corall reefs and the zooxanthallae and an initial plan of the floating PV system application.

Keywords: sea condition, floating PV systems, coral reefs, zooxanthellae, light, water body temperature.

1. Introduction

The Thousand Islands is an area consisting of many islands located at longitude of 106 ° 25’-106 ° 40 and latitude of 05 ° 24’-05 ° 45’ (See Fig 1). The Seribu Islands are part of the capital city of Indonesia, namely Jakarta. Due to its archipelagic geographic condition, the population is mostly fishermen. The fisherman, apart from being a fisherman who do fishing in the off shore, the profession of fishermen here also do fish farmings or aquaculture. Fish farming is an activity that is very encouraged, because there are many types of fish in the Seribu Islands area that have high economic value. The fish that are often found here are reef fish [1]. Because indeed the characteristics of the Thousand Islands are small islands with shallow beaches and seas, and the existence of coral reef areas. However, now the condition of coral reefs is threatened, numerous coral reef areas have been damaged and died. Eventhough, the environment of coral reefs is one of the very productive ecosystems and is very vulnerable to environmental changes.

The cases of the damage of coral reefs in the Seribu Islands, according to [2], the cover value ranges between 13.74% for non-tourism areas and 55.83% for tourist areas, then the mortality index around these areas can be around 0.5 for non-tourism areas and 0.2 for tourism. This may caused by the increase in sea water temperature, in addition to other factors such as human actions and the percentage of salinity. According to Suharsono (1998) [3] during El Nino, there was an increase in temperature in this area which caused coral death due to bleaching, and the areas reviewed in this
study were Bidadari Island, Pulau Air and Pulau Jukung. The occurrence of cases of bleaching at high temperature is due to the release of zooxanthella from the coral system. In general, the average temperature of the waters in the Thousand Islands reaches 28.5°C to 30.3°C, while the average light intensity value reaches 0.801 Cd to 120.869 Cd [4].

The correlation between coral mass-bleaching events and elevated sea-surface temperature (SST) is well proven[5,6], additionally, the absence of light does not have any impact on corals bleaching [7]. This coral damage will ultimately be detrimental to fishermen, because the type of reef fish depends on the condition of the reef. Moreover, the life of the coral reef is also determined by the existence of a life of algae,namely the Zooxanthellae. Zooxanthellae are one-celled algae that live in the body tissue of stony corals. Zooxanthellae and corals have a mutually beneficial symbiotic relationship, which is a group of phytoplankton, namely dinoflagellates, and inhabits the gastroderm polyp. Therefore, there are corals called hermatypic organisms (building corals) [8]

The impact of the destruction of the coral reef ecosystem is seen in the decreased fishermen's catch. The catch reduction is not only occurs in reef fish (demersal), especially grouper species. Economically, this thing it has a direct effect on the level of people's income because most of the people in this region are completely dependent their livelihoods from capture fisheries production in the fishing location, that is mainly in the waters around the reef ecosystem coral.

In the Seribu Island, currently, many of the fishermen develop aquaculture, since there is a great opportunity to do fish cultivation. There are many fish coral such as Grouper Fish. However, this fish farming also requires a device to be able to regulate water temperature and pH and salinity conditions. This device is called aerotor and it requires energy, which currently depends on electricity from fossil fuels. So we need an alternative energy, and one of the most promising is solar energy. The use of solar energy is already in an advanced stage, the 'Floating PV System'.

This paper, therefore, is investigated the potential of the floating PV system to help minimize the impact of rising surface temperatures and high solar irradiance. This investigation is carried out by conducting a literature study, which will consist of a study of sea conditions in the Seribu Islands and the advantages of floating PV system applications. The outcome of this study is an initial recommendation for the application of the floating PV system for the Seribu islands. The development policy DKI Jakarta, then the development of the archipelago a thousand directed to: Increase activities tourism, improve the quality of life fishing communities through increased cultivation sea and utilization of fishery resources by conservation of coral reef.
2. Condition of Coral Reefs in the Seribu Islands

Seribu Islands with a position extending from the North to the South characterized by small white and sandy islands charred, basically is clusters of coral reef islands formed and formed by coral biota and associated biota (algae, molluscs, foraminifera and others) with natural dynamics process assistance. These waters cover an area of 6,997.5 km², having 110 islands and coral reefs that are relatively very small, 70% of them have an area of less than 10 ha. Presence of reefs The corals in these waters have important significance for the people of the Islands A thousand, most of whom work as fishermen, because they are demersal fishing area. Moreover, the area is location of coral and sand mining activities for material needs building. The study conducted by [9] recorded that 72% The people of the Seribu Islands depend on their livelihoods coral reef ecosystem. On the other hand, ecosystem damage coral reefs that occur in these waters, through mining activities coral and sand as well as fishing activities using potash and explosives, have destroyed a large part of the reef ecosystem existing corals [3]. Based on Terangi's inventory [9] noted that the coverage of coral reefs in the Seribu Islands in 2007 it was 29%, down from the 2005 cover, that is 33.2%.

As described in the Introduction, the coral reefs depends on an algae called the Zooxanthellae. The symbiosis relationship can be illustrated as follows [10,11,12]:

Zooxanthellae require sunlight to form buildings from limestone which became known as reef building corals, Zooxanthellae are single-celled algae that live in the body tissue of rock corals. Zooxanthellae and corals have a mutually beneficial symbiotic relationship, which is a group of phytoplankton, namely dinoflagellates, and inhabits the gastroderm polyp. Therefore, there are corals called hermatypic organisms (building corals). The coral itself is a group of Coelenterata in the form of polyps.

Usually they are found in large numbers in every living polyp in symbiosis and give polyps their color, energy from photosynthesis and 90% of the polyp's carbon requirements. Zooxanthellae receive essential nutrients from coral (polyp) and provide as much as 95% of their photosynthetic output (energy and nutrients) to polyps [10].

![Image](image.png)

Figure 2. The mechanism of the coral and the zooxantellae
Source [10]

The number of zooxanthellae in corals is estimated to be > 1 million cells / cm² of coral surface, some say between 1-5 million cells / cm². Although able to live independent of the parent, most
zooxanthellae do symbiosis in this association, corals get a number of advantages in the form of: (1) Photosynthesis products, such as sugars, amino acids, and oxygen, (2) Speed up the calcification process and (3) Photosynthesis will raise PH and provide more carbonate ions.

3. Floating PV System

Steemann Nielsen (1964) and Jitts et al. (1976) showed that incident levels of UV radiation at the surface of the sea could severely inhibit photosynthesis [12]. In addition to being able to utilize the reflected light from the water surface, the floating PV is known to be about 11% more efficient than the terrestrial solar panel due to the temperature reduction effect in water [2]. Solar panels that cover the water can also reduce evaporation [3] and prevent algae [4] due to shadows by the panels. In other words, the floating PV is advantageous in terms of efficiency and environmental aspects, in addition to the lack of need for land [13]. Figure 3 shows the heat balance of the advantage on reducing the excessive ultraviolet over sea surface since the initial solar incident on the panel is converted into electricity.

In general, a floating PV system covers a large area of water surface and is thus able to effectively reduce water evaporation [14]. This study also showed that the surface temperature of a water body can be reduced, subsequently, the coral reefs could get this advantage. The bleaching of the coral reefs may reduce, as well as resulted in shaded light into the water body. This result is beneficial for the growth of algae.

Various investigators observed that incident light is an important growth factor in the form of photon flux density [10]. Vital role of light is assimilation of carbon dioxide. Algal growth is affected by different types of shading light. Algae growth is inhibited by shedding light. Studies have shown that green algae grow better in blue and red light because they contain chlorophyll a and b which are major light harvesting pigments and sensitive to these wavelengths. Temperature strongly influences the cellular chemical composition, uptake of nutrients, CO2 and the growth rates for every species of algae [11].
4. Concluding remarks and future recommendation

A review on the sea condition in the Seribu Island that focused on the coral reefs and zooxanthallae has been conducted. As well as the potential of the utilization of the floating PV systems over the Seribu Island sea waters. The followings are the concluding remarks and an initial recommendation for the usage of floating PV system:

- There is a symbiosis relationship between coral reefs and the zooxanthallae in which the water temperature and the light is used in their biological activities such as photosynthesis. If this is interrupted will result in mortality.
- High solar incident that resulted in high water temperature cause the bleaching of the coral reefs.
- The necessary light for the zooxanthallae is the shaded light.
- Since the sea condition of the Seribu Island contains many coral reef which The recommendation for the future usage of the floating PV system can be as follows:
  - PV panels must be arranged in small areas. it is not recommended to manage in a large area. this is to provide a shaded sun light.
  - In the installation, a cavity between the waters and the panels should be provided to allow convection.
  - The design of the construction should avoid any obstruction to the coral reefs.

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