SEAWEED FARMING

THE HISTORICAL, ENVIRONMENTAL, AND ECONOMICAL ASPECTS

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Introduction

Seaweed is usually thought about in Asian cuisine but seaweed derivatives are used every day in functional foods, medicine, and more. It has various health benefits in form of vital vitamins, proteins, minerals, and the ever so sought after omega fatty acids (Norziah & Ching, 2000). This paper summarises the key principles of the historical, socio-economical, and environmental aspects of seaweed farming and explains how the expansion of seaweed farming can help climate change mitigation and adaptation.

History of Seaweed Usage

Human usage of seaweed can be traced back to the late Palaeolithic period about 14,000 calendar years ago. The findings at archaeological sites seemed to suggest that seaweed were a valuable and imperative source of food and medicine (Dillehay, *et al.*, 2008). Throughout history seaweed remained an important, albeit underrated, source not only for human consumption and for medicinal purposes, but also as animal feed, fertiliser and other domestic purposes such as building materials. Additionally, seaweed was used industrially for the production of glass, soap, and the production of iodine in the form of potash (Delany, *et al.*, 2016).

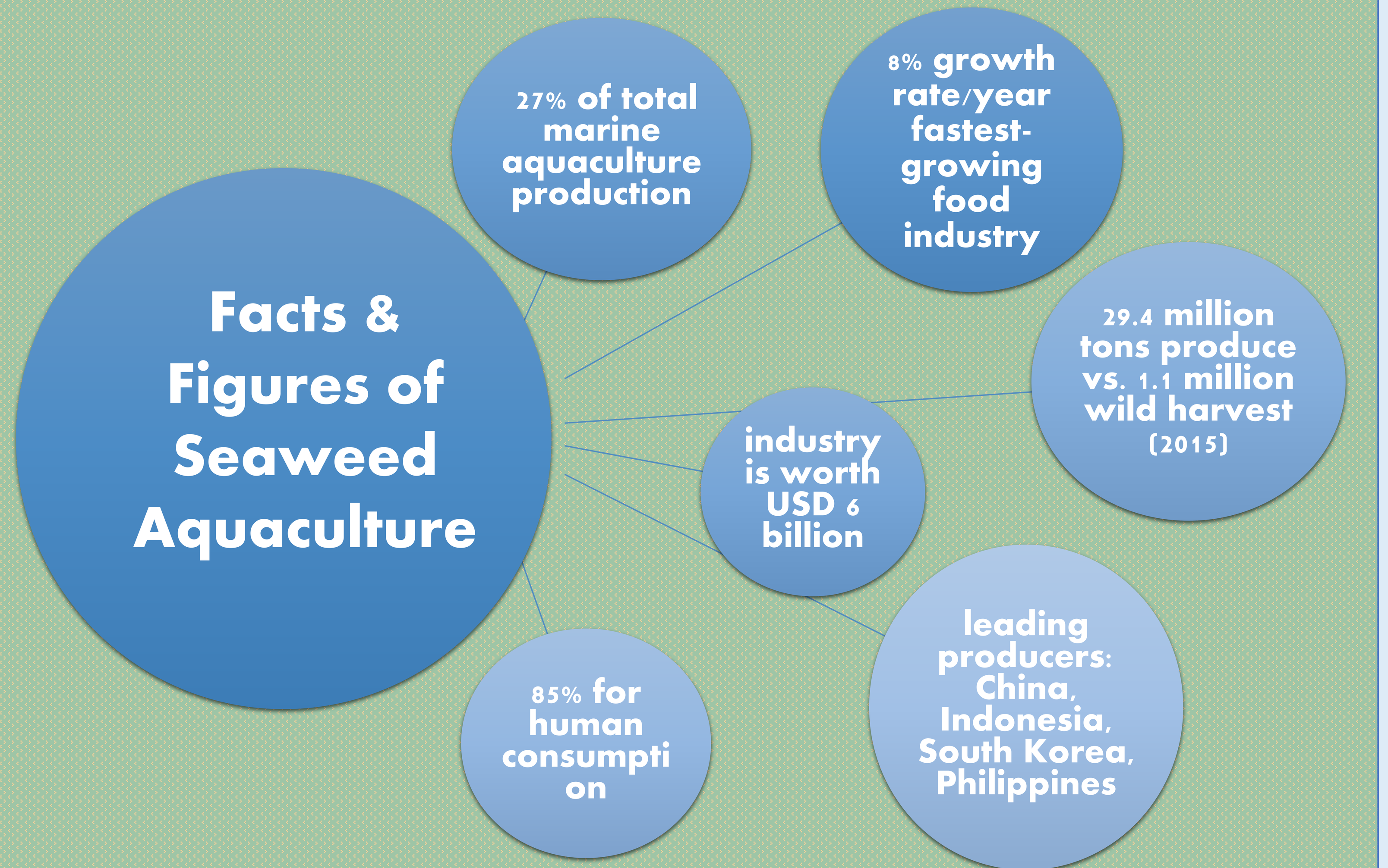

Fig 1: Facts and figures of seaweed aquaculture (Ferdouse, *et al.*, 2018).

Seaweed Use Today

Historically seaweed was mostly wild harvested by hand on shore or in shallow waters, or mechanically on boats. Hand harvested seaweed was traditionally done by women in some countries and this practice remains dominant in some parts of the world today, although it has changed in many others (Delany, *et al.*, 2016). Today, seaweed farming plays an important role for the industrial uses of those algae, namely in the form of hydrocolloids (alginate, agar-agar, and carrageenan). These components became instrumental for the production of cosmetics, nutraceuticals, and pharmaceuticals as well as for animal feed, textile, paper, and paint industries (Anis, *et al.*, 2017). Seaweed derived to manufacture those products are mainly red algae (agar and carrageenan) and brown algae (alginates and carrageenan) with some few green algae used (Fig 1). Furthermore, seaweed has shown promising results used as biofuel. Algal biomass can be converted into transportation biofuels such as biodiesel, biobutanol, and bioethanol (Fernand, *et al.*, 2017).

Possible Climate Change Mitigation and Adaption Effects

The farming of seaweed could have a profound part in climate change mitigation in terms of CO_2 uptake, substitution of fossil fuel, and ocean acidification and their respective knock-on effects.
Seaweed aquaculture, as it is now, plays only a minor role in CO_2 uptake but on a slightly larger scale it could reach a sequestration intensity of about 1,500 tons CO_2 per km/y (Duarte, *et al.*, 2017).
Additionally, macroalgae have been found in oil deposits and abyssal isopods, which suggests macroalgal drift to the deep seafloor and therefore the movement of carbon from shallow waters to carbon sink locations aiding long-term carbon sequestration (Fig 2) (Krause-Jensen & Duarte, 2016).
Some impacts caused by ocean acidification can also be alleviated with seaweed farms. The uptake of certain quantities of carbon through photosynthesis have shown to increase the pH on a local scale (Krause-Jensen, *et al.*, 2016).
Moreover, coastal areas, which are particularly affected by eutrophication, are prone to ocean de-oxygenation and ocean warming (Diaz & Rosenberg, 2008). Seaweed are autotrophic in nature and take up ecxess nutrients, in which seaweed farms can prevent hypoxia due to it being harvested before the remineralisation and consuming of oxygen can take place (Duarte, *et al.*, 2017).

Seaweed as a substitute for fossil fuels can be another factor for the mitigation of climate change effects. Algal biomass can be transformed into transportation liquid biofuels, which suggests elimination of greenhouse gas emissions in large parts by using biofuels out of macroalgae, which may have great potential in conversion efficiency and yield and it additionally takes pressure off terrestrial crops with significantly higher carbon footprint (Chen, *et al.*, 2015).

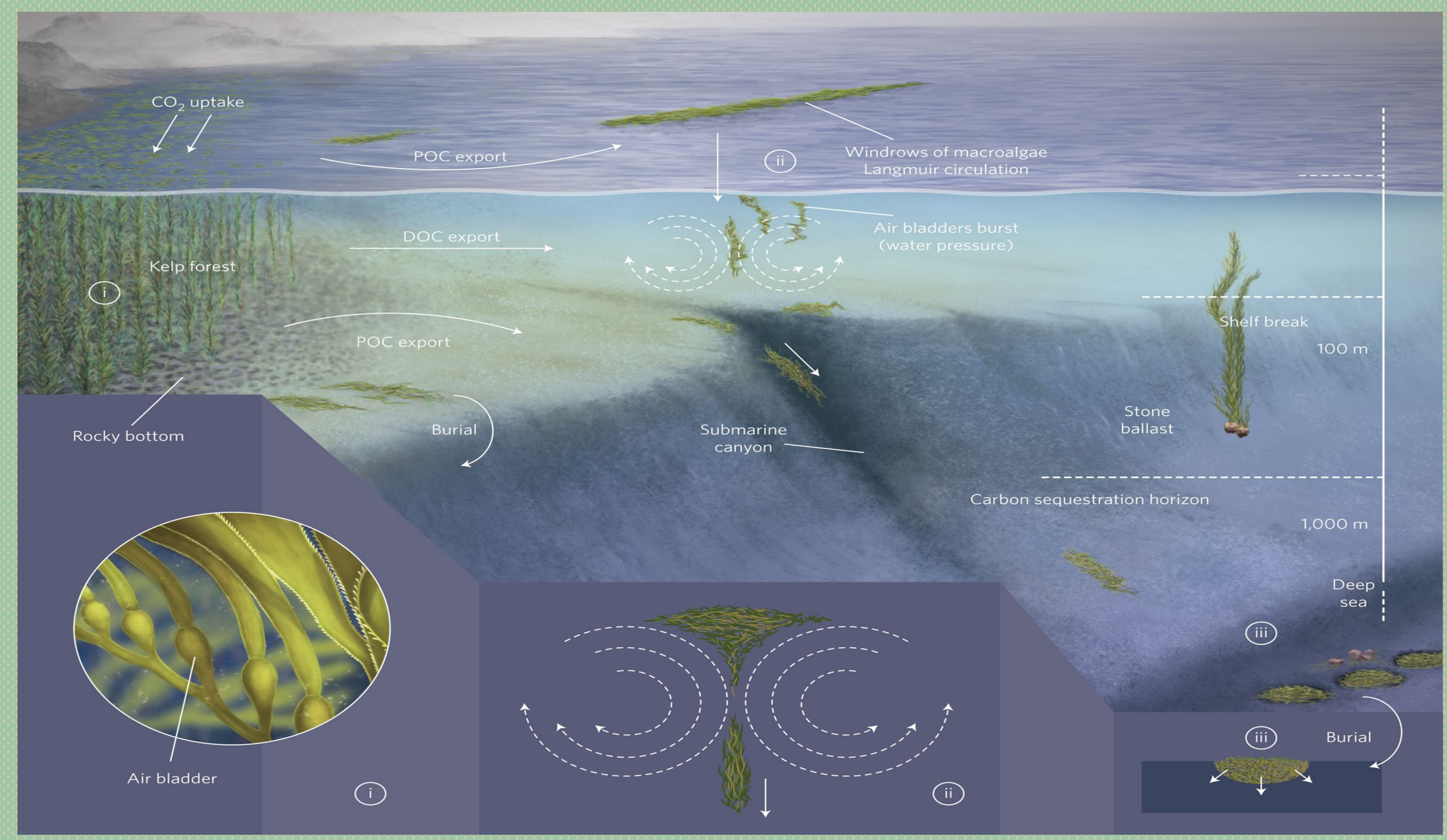

Fig 2: Diagram of possibple pathways and export of macroalgal carbon (Krause-Jensen & Duarte, 2016).

Socio-Economic Benefits

The socio-economic values of seaweed farms may give further incentive to increase macroalgae farming. The expansion of seaweed farms would create jobs and skilled labour forces, as well as the development of new technologies. In addition, subsidies or compensation for seaweed farmers for actions to mitigate climate change need to be assessed to encourage farmers to take part in seaweed farming (Duarte, *et al.*, 2017).

Conclusion

Seaweed is already a staple food source and part of a rising industry for farmed produce. The expansion of seaweed farms, if done responsibly and sustainably, can mitigate climate change effects such as reducing GHG emission by converting seaweed biomass into biofuels, it can assist with carbon sequestration, and lessen ocean acidification and eutrophication. Furthermore, seaweed farming brings economic benefits in form of new jobs and technologies, and can aid with the overfishing problem and the dependence on fish for essential nutrients.

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