# Ecosystem Services Associated with Seaweeds in Circular Bioeconomy Context


Ph.D. Student

**Xueqian Zhang**

Supervisor

**Marianne Thomsen, AU-ENVS**

Co-Supervisor

**Annette Bruhn, AU-BIOS**


AARHUS UNIVERSITY

AU ENVS EISA

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# 1 Seaweed Resources Worldwide

Xueqian Zhang
xgzh@envs.au.dk | CBIO Seminar
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Seaweeds, or marine macroalgae, are plant-like organisms that generally live attached to rock or other hard substrata in coastal areas.

Seaweeds deliver important ecosystem services [1]:

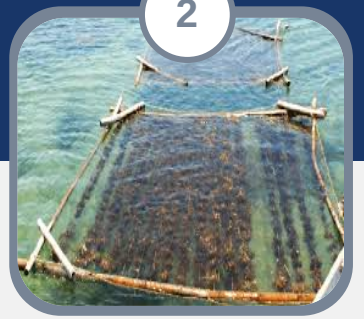
- provisioning (primary production)
- regulating (nutrient cycling, carbon cycle regulation, wave attenuation, and costal protection)
- supporting (photosynthesis and habitat)
- cultural (aesthetic, recreational, spiritual, and educational value)

1

## Wild Standing Stocks

Examples: Kelp forests in Norway; *Sargassum* populations in Morocco.

2



## Cultivated Seaweeds

Examples: Off-shore *Saccharina latissima* cultivation in North Europe; On-shore tank cultivation of *Ulva* spp. in Australia; Near-shore *Kappaphycus* farming in Indonesia.

3

## Seaweed Tides

Examples: Green tides (*Ulva* spp.) and golden tides (*Sargassum* spp.)

4

## Epiphytic Seaweeds

Example: Red macroalgae *Vertebrata lanosa*

[1] Thomsen, M., & Zhang, X. (2020). Life cycle assessment of macroalgal ecoindustrial systems. In M. D. Torres, S. Kraan, & H. Dominguez (Eds.), Sustainable seaweed technologies: cultivation, biorefinery, and applications (pp. 663-708). Elsevier. Advances in Green and Sustainable Chemistry. DOI: 10.1016/C2018-0-01462-0

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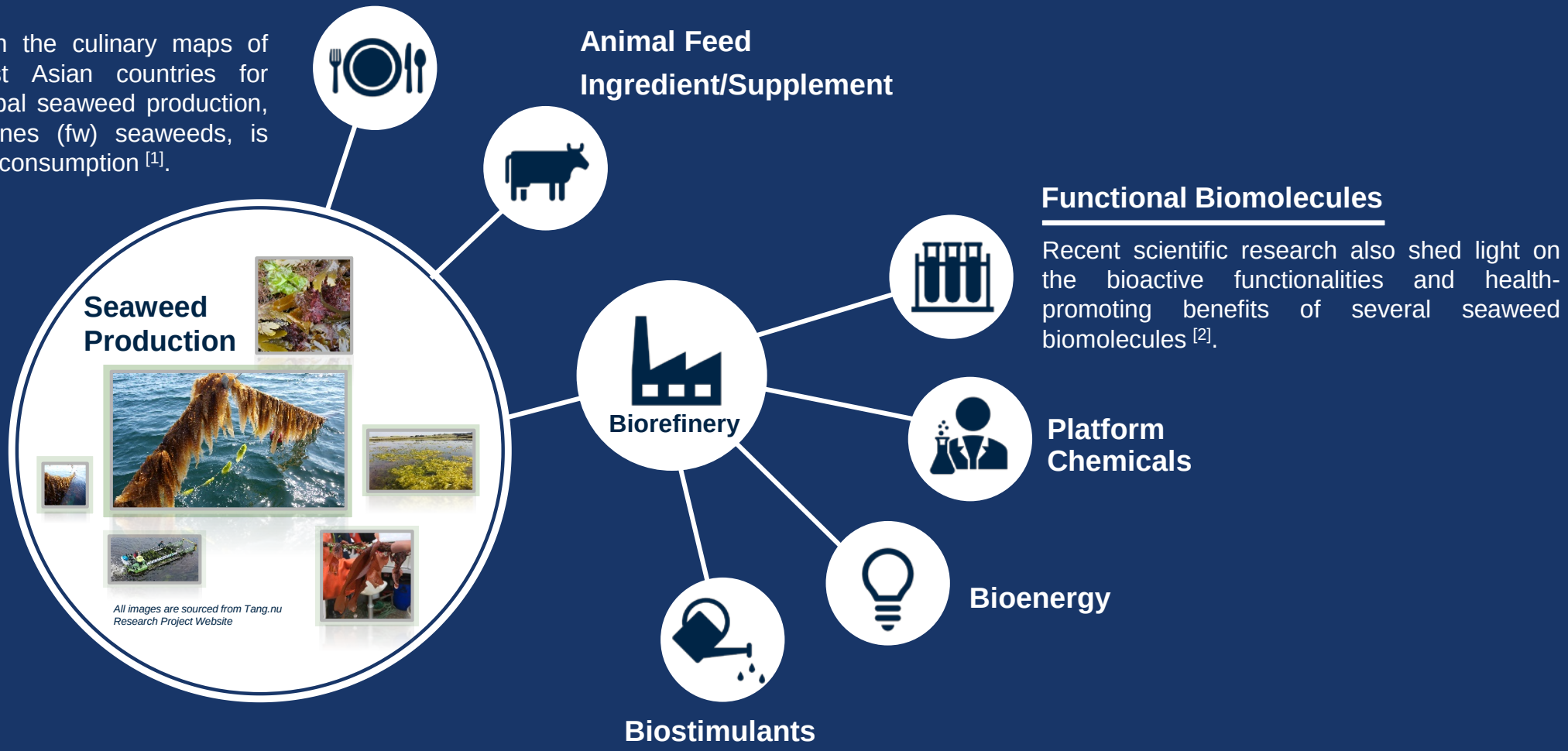
# Provisioning Ecosystem Service - Versatile Biomass

Xueqian Zhang
xgzh@envs.au.dk


## Human Food

Seaweeds have been on the culinary maps of coastal regions in East Asian countries for centuries. Half of the global seaweed production, i.e., around 15 Mio tonnes (fw) seaweeds, is intended for direct human consumption [1].




## Functional Biomolecules

Recent scientific research also shed light on the bioactive functionalities and health-promoting benefits of several seaweed biomolecules [2].

[1] Zhang, Xueqian; Thomsen, Marianne (2020), "Global production of seaweeds and trades of seaweeds and seaweed-derived hydrocolloids (agar-agar, alginate, and carrageenans)", Mendeley Data, v1. DOI: 10.17632/2tt3z8rjxf.1.
[2] Zhang, X., & Thomsen, M. (2019). Biomolecular composition and revenue explained by interactions between extrinsic factors and endogenous rhythms of Saccharina latissima. Marine drugs, 17(2), 107. DOI: 10.3390/md17020107

# The Need of Eco-industrial Systems in the Transition towards Circular Bioeconomy

Xueqian Zhang
xqzh@envs.au.dk

CBIO Seminar
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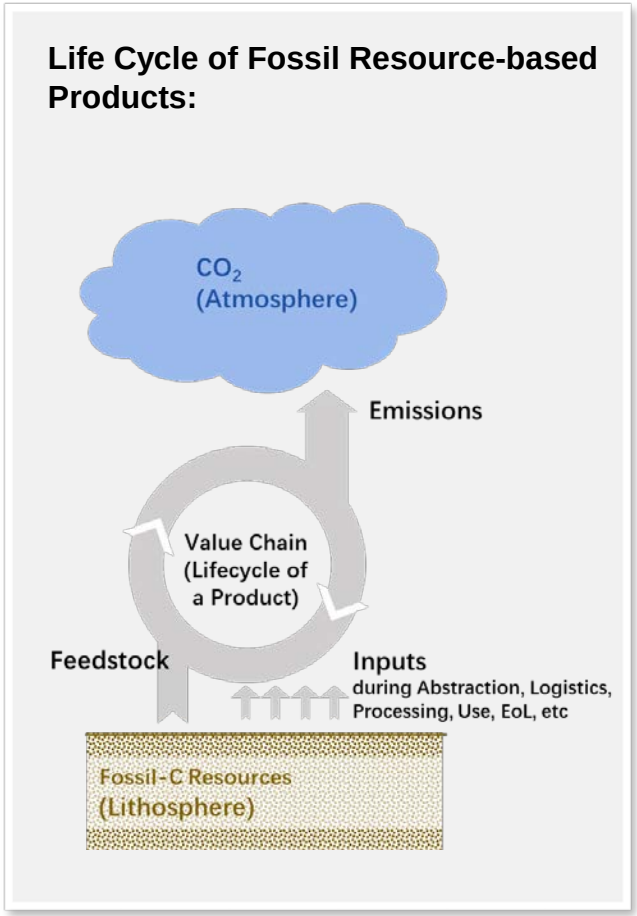
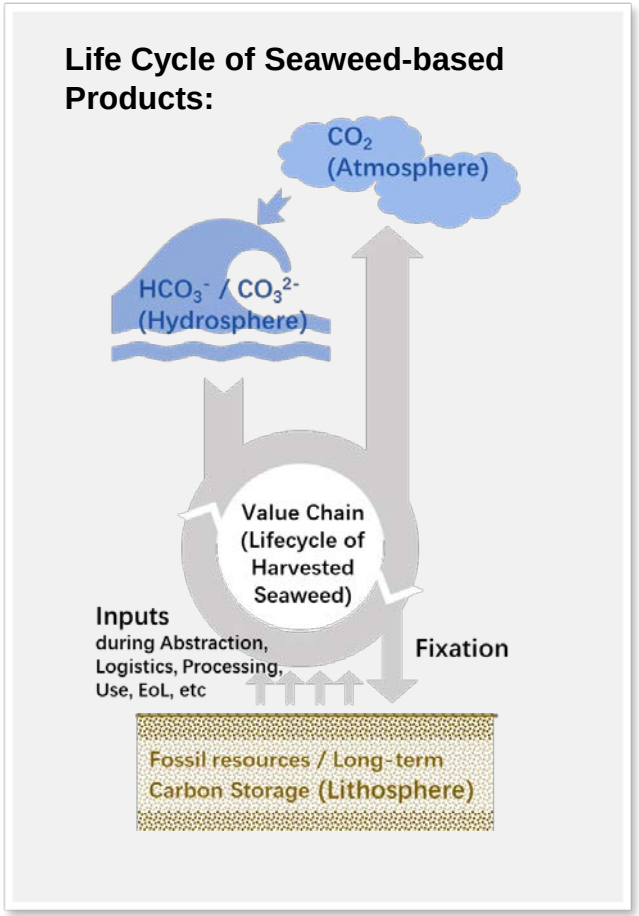
## Critical Biophysical Planetary Boundaries [1]

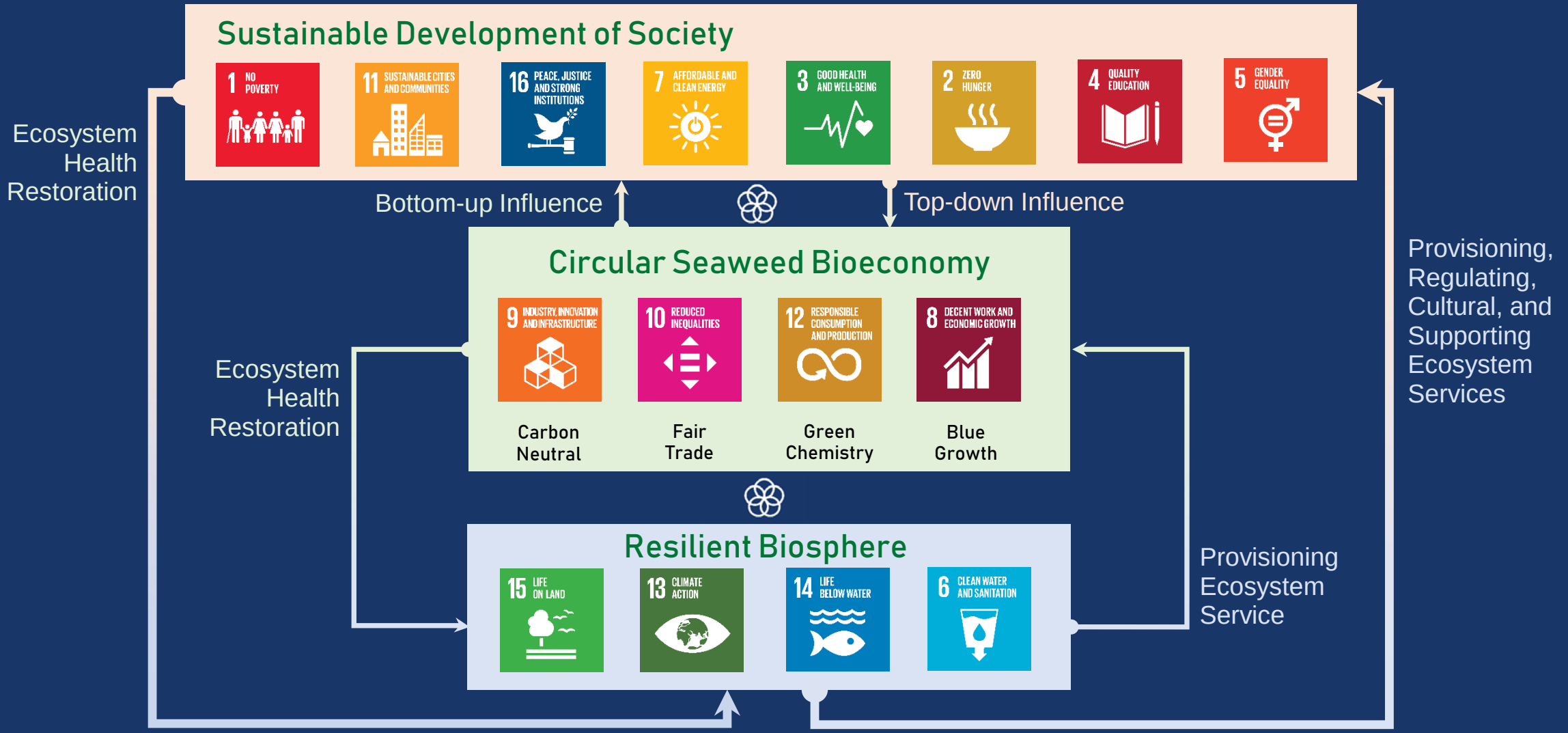

## Exemplifying the Impacts of Feedstock Selection on Carbon Cycle [2]




[1] Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., ... & Folke, C. (2015). Planetary boundaries: Guiding human development on a changing planet. Science, 347(6223). DOI: 10.1126/science.1259855
[2] Zhang, X. (2020) Lecture "Engineered Ecosystem Services Delivered by Seaweed Cultivation & Whole Value-chain Sustainability" at the PhD course "Circular Bioeconomy". Contact: xqzh@envs.au.dk or LinkedIn.

# 4 Addressing Global Societal Challenges by Establishing Local Regenerative Circular Seaweed Bioeconomy [1]




[1] Thomsen, M., & Zhang, X. (2020). Life cycle assessment of macroalgal ecoindustrial systems. In M. D. Torres, S. Kraan, & H. Dominguez (Eds.), Sustainable seaweed technologies: cultivation, biorefinery, and applications (pp. 663-708). Elsevier. Advances in Green and Sustainable Chemistry. DOI: 10.1016/C2018-0-01462-0

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