Fluidic COMSOL Multiphysics Analysis Of Shore-based Farm Design For Sustainable Seaweed Aquaculture

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Abstract

Recognized for its potential as a sustainable food source, seaweed farming has become pivotal in tackling future food security concerns, necessitating innovative solutions to achieve optimal, high-yield, and commercially viable production [1]. This work addresses gaps in aquaculture seaweed farm design by investigating the correlation between farm geometry and the coastal water environment using PDE Module of COMSOL Multiphysics. With implemented 2D shallow water equations we performed comparison of important seaweed farm parameters such as wave height, wave velocity and turbidity between different geometrical arrangements of seaweed plants. Among these parameters water turbidity is of special importance for seaweed aquaculture is it is closely linked to nutrient absorption and seaweed growth rate [6]. Our results show that the randomized rectangular patterns and checkerboard patterns offer highest turbidity with maximum values exceeding by ~37% simplistic rectangular arrangements traditionally used in seaweed farms. These findings will pave the way for smart, high efficiency seaweed farm design and can lead to new sustainable solutions for scalable aquaculture.

Reference

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Figures used in the abstract

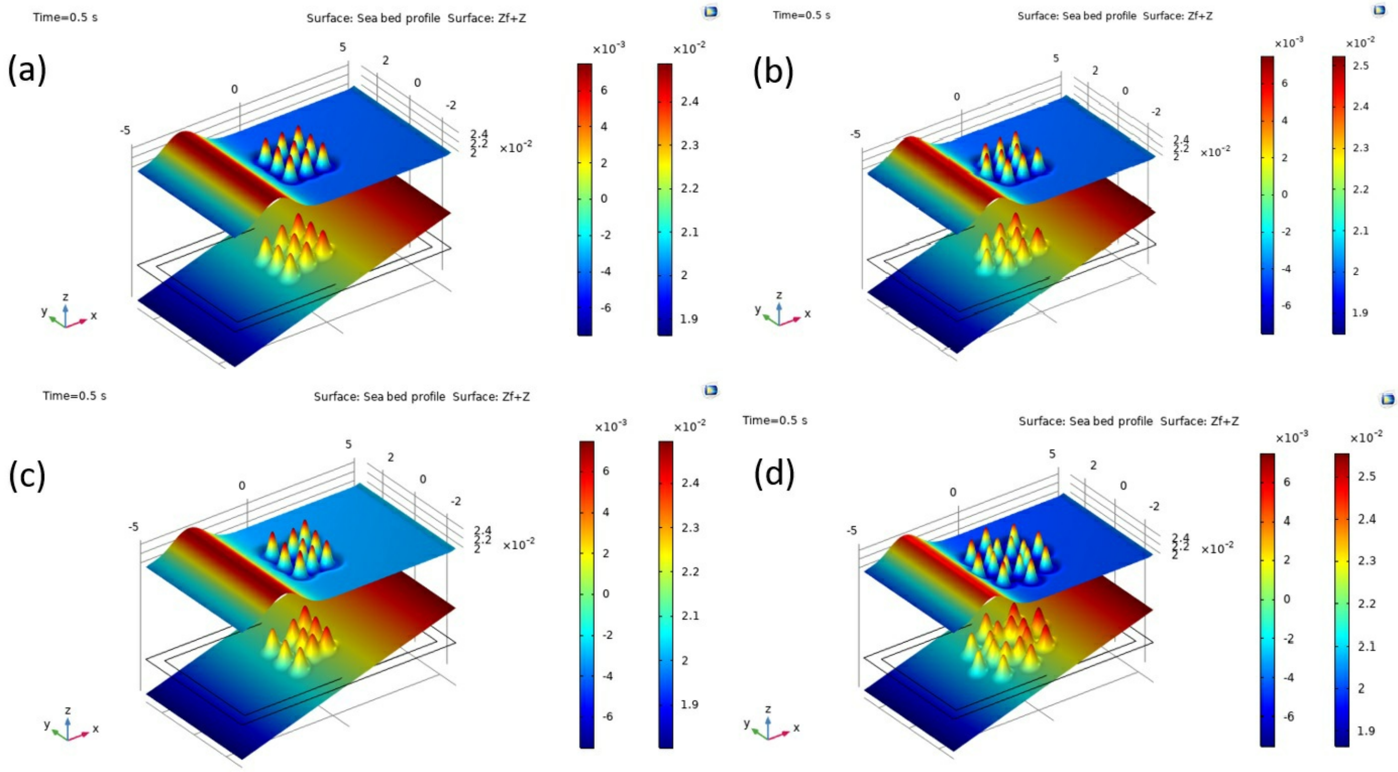

Figure 1 : Figure 1. Comparison of wave heights for different structures. Rectangular (a) Checkerboard (b) Randomized (c) Spiral (d) Underlying geometry is plotted on the background

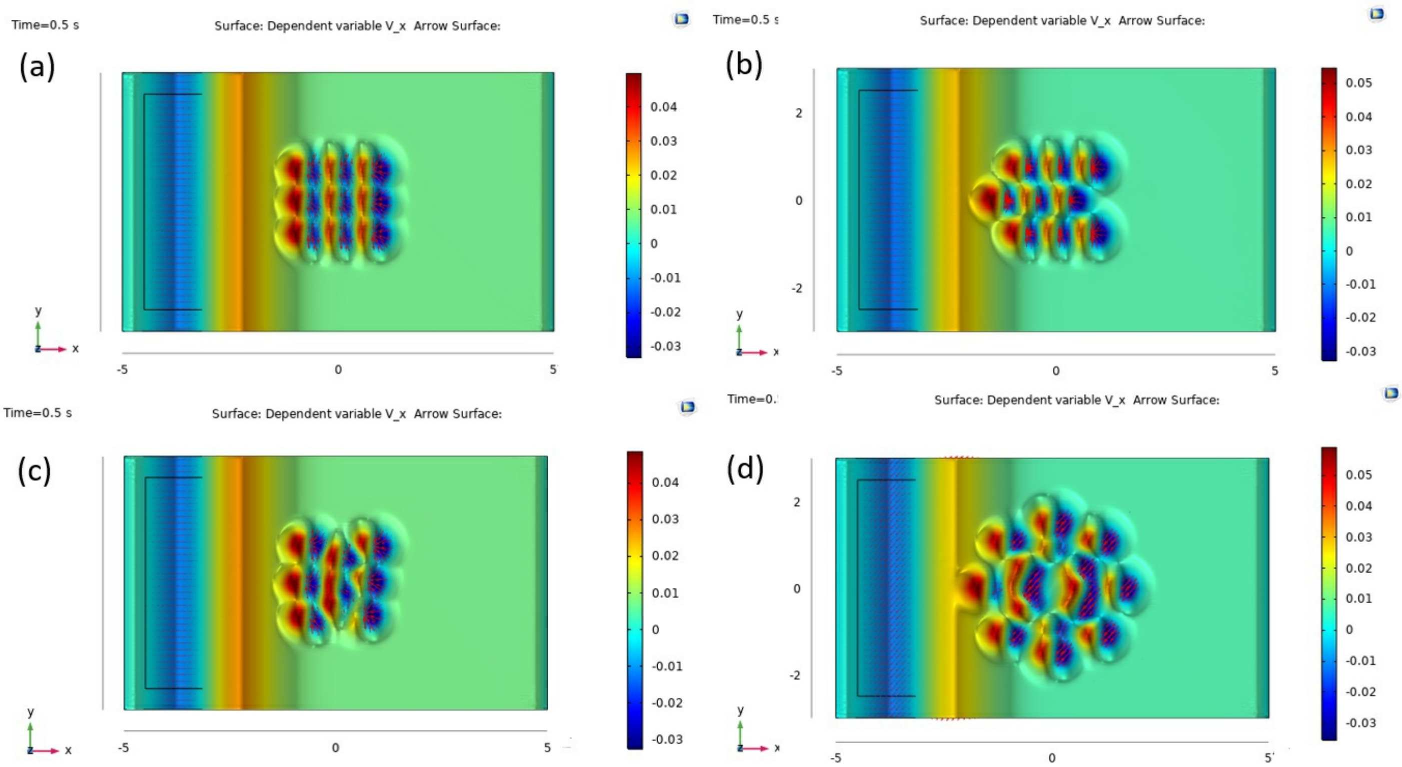

Figure 2 : Figure 2. Comparison of wave velocity for different structures. Rectangular (a) Checkerboard (b) Randomized (c) Spiral (d) Arrow lengths are proportional to local velocity

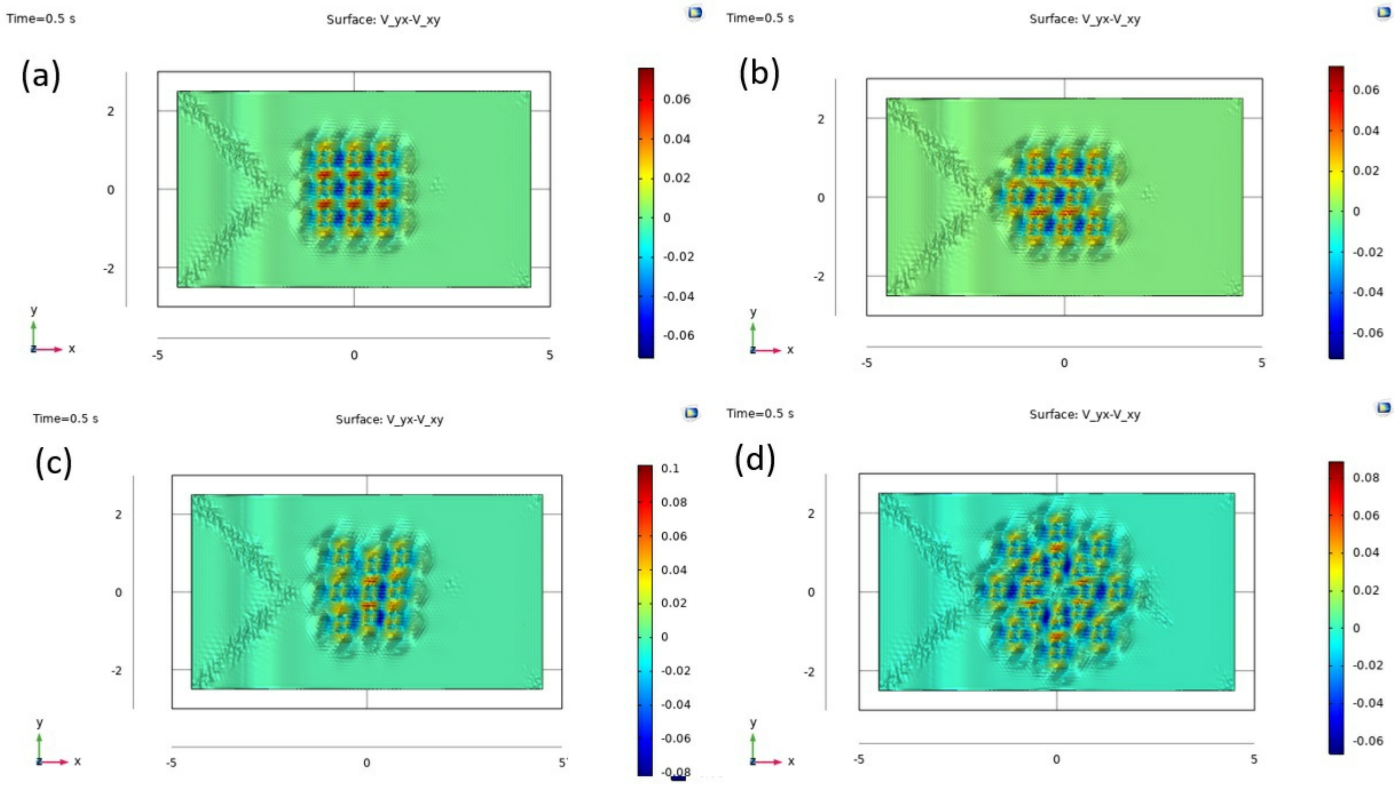

Figure 3 : Figure 3. Comparison of turbidity (curl of velocity) for different structures. Rectangular (a) Checkerboard (b) Randomized (c) Spiral (d)

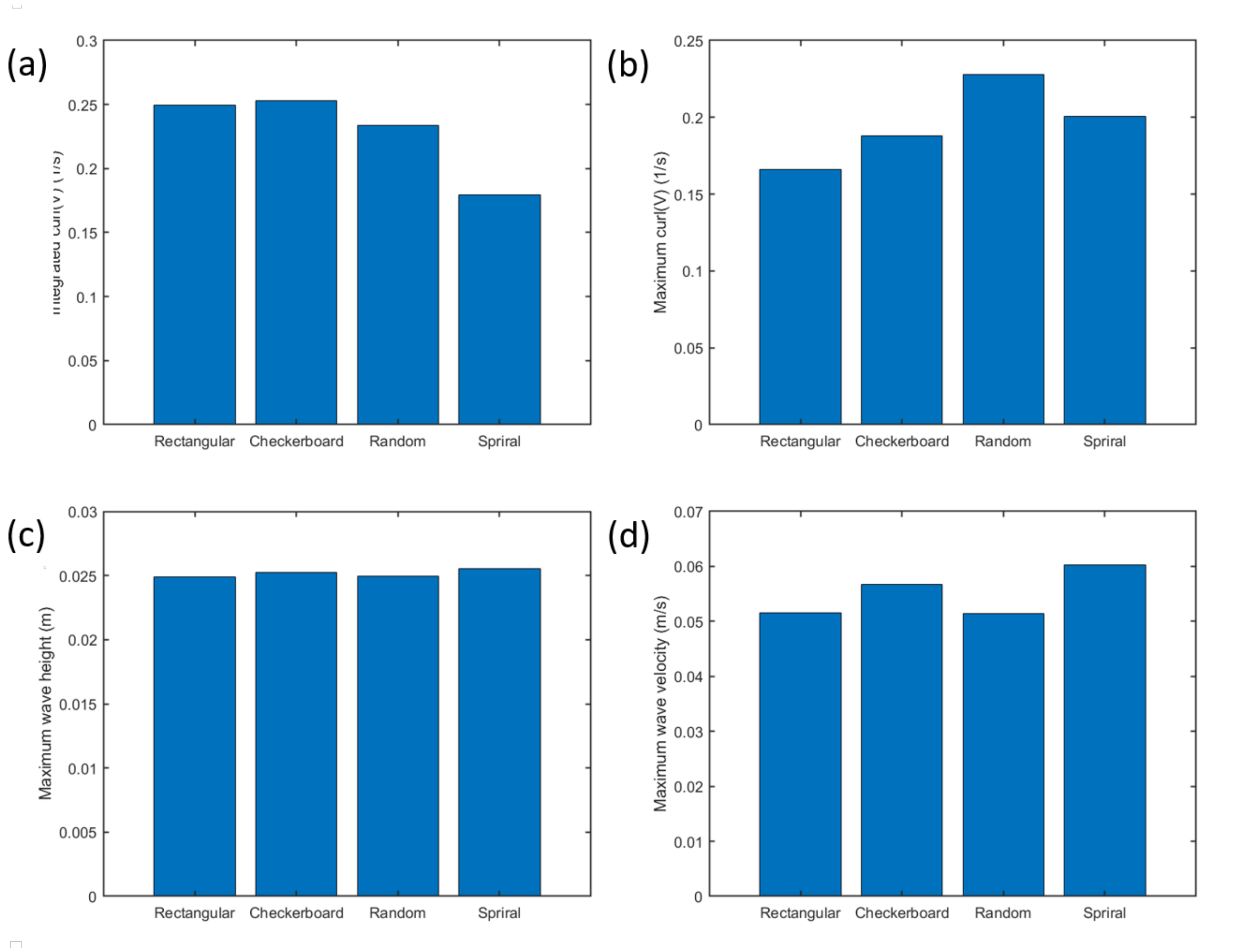

Figure 4 : Figure 4. Comparison of system parameters for different geometries. Integrated turbidity (v) (a) Maximum turbidity (v) (b) Maximum wave height (c) Maximum wave velocity (d)