



Hydrodynamic services to support the development of your seaweed farm

Seaweed farms are currently placed near shore in sheltered locations. However, a strong desire exists to expand towards offshore locations for the sake of large scale seaweed cultivation. New innovative seaweed cultivation designs that can withstand the offshore conditions are currently being developed. MARIN has a long track record on (extreme) environmental loading on a variety of offshore structures serving the Oil & Gas, offshore wind and aquaculture industry. Therefore we are in the position to offer services and advice on loading on your offshore seaweed farm in exposed environments. Through state-of-the-art numerical models and model test campaigns the loading and response of your farm can be determined. These assessments will provide you adequate input to understand hydrodynamic and structural viability of your design.

Services:

- Conceptual phase: Feasibility study
- Design phase: determine wave and current loading to assist in the design process
- Full scale monitoring: ensure safe operations for offshore seaweed farms

State-of-the-art research

MARIN is currently active in pursuing research activities for large scale offshore seaweed cultivation. We are of the opinion that a comprehensive assessment of seaweed growth potential for a specific configuration and site need to be based upon a multi disciplinary approach. Hydrodynamics, ecology, nutrient dynamics and hydrodynamics are strongly interlinked and will determine the “performance” of a farm. With an internationally renowned status in hydrodynamic research MARIN joins forces with all major research institutes in the Netherlands to develop the know-how for large scale seaweed cultivation.

Conceptual phase: Feasibility study

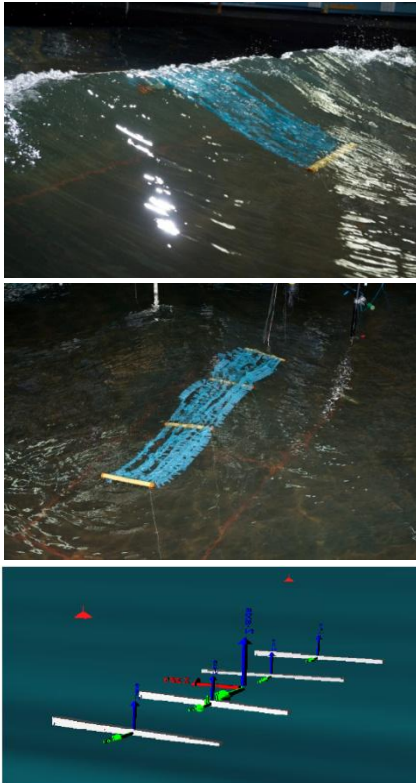
In the conceptual phase, a hydrodynamic feasibility assessment can support you with the siting and configuration of your seaweed farm for the prevailing sea states of your location. With our partners we can assess hydrodynamics jointly with nutrient dynamics and nutrient uptake for your site. MARIN can conduct the hydrodynamic feasibility by means of concept model tests and numerical simulations to give insight into the driving hydrodynamic parameters such as loading and motion response of the farm. Various configurations and operating strategies can be evaluated and compared on key performance indicators, including aspects such as safety, operational risk and maximum operability.

Design phase: Model tests to verify loading and safety

The hydrodynamic behaviour of seaweed farms (due to strong interactions of



Seaweed modelled by making use of surrogate material. Top figure: fully moored multi long line model (scale 1:25). Bottom figure: Laminaria digitata surrogate (1:1)



Top and middle figure: Seaweed model test in waves. Bottom figure: aNySIM numerical time domain model which can be validated by the model test results and in turn used in your seaweed farm design process.

Related products:

- Operability assessments for offshore support vessels
- MARIN services in fish farms

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fluid and structure) is considered to be very complex. In our opinion this behaviour can only be assessed in detail through model tests or prototype testing. MARIN offers model tests in a wave basin and/or towing tank to assess the behaviour in (extreme) waves and/or current loading. This assessment can support you in understanding the structural integrity in extreme environmental loading on your seaweed farm for the prevailing sea state at your site of interest. Furthermore you will gain a thorough understanding on the loads and responses of your seaweed farm design including floater behaviour and mooring system behaviour. MARIN can independently verify and validate the offshore seaweed farm design and perform a check if the system meets requirements and specifications as set out by e.g. major certification bodies.

Full scale monitoring: assess the prototype or monitor your farm in operation

When the seaweed farm is in operation, full scale monitoring can give further insight in the performance of the design. For this MARIN's trial and monitoring department can perform these measurements campaigns using their wide experience from the offshore Oil & Gas and offshore renewable market.

State of the art tools

Developed in-house, aNySIM XMF is state-of-the-art software for hydrodynamic time domain simulations that is suitable for modelling seaweed farms. Detailed assessments can be carried out in our high-end wave basins to gain insight into the motions, accelerations and loading on the seaweed farm. These model tests are essential in proof-of-concept demonstration and in certification.

Expertise and experience

MARIN is an independent and innovative service provider specialising in hydrodynamic assessments and investigations. With over 80 years experience, we are fully conversant with challenging metocean conditions in Oil & Gas and renewable energy projects worldwide. MARIN offers services for hydrodynamic analysis of various types of floaters, installations and operations offshore. Our expertise includes concept validation, seakeeping, slamming, operability assessments, hydrodynamic assessments on installation and maintenance operations, motion compensation and control, mooring, dynamic positioning and logistic scenario analysis. Experience on seaweed farms includes:

- North-Sea-Weed-Chain Sustainable seaweed from the North Sea; an exploration of the value chain, F Groenendijk et al. 2016: In this project five applied research institutes, ECN, TNO, WUR-DLO, MARIN and Deltares, covered the required multi-disciplinary approach required to assess the seaweed value chain.
- Concept model tests for Noordzeeboerderij: MARIN performed concept model tests to assist North Sea Farm Foundation with their seaweed farm design