


It's about time for a blue revolution

Food from water to feed the world



WAGENINGEN
UNIVERSITY & RESEARCH



2050: 9.5 billion people to feed and provide with drinking water. How can we do this? By exploring the possibilities of getting food and feed from large waterbodies.

70% of the earth consists of water. Today only 17% of our food comes from fisheries and aquaculture. Wageningen University & Research strives to enhance food and feed production from our currently underused large fresh and marine waterbodies such as lakes, rivers and our seas and oceans.

On land space and water are becoming scarce commodities. Yet our planet consists for 70% of water, with 95% of our water reserve in our oceans and seas. Today we are not using this potential to its fullest.

The “green evolution” enabled us to feed the current world-population; a “blue revolution” is needed to feed the world by 2050. Wageningen University & Research identifies the possibilities and potentials of a “blue revolution”. We do so by identifying the factors that define, limit and reduce ocean production, by outlining the trade-offs between alternatives and scenarios for sustainable production in harmony with nature and by the development of innovations. Together with partners from other research institutes, policy makers, industry and societal organisations we work in a range of different successful projects of which we present a selection below.

The strength of Wageningen University & Research lies in its ability to join the forces of specialised research institutes and the university. It also lies in the combined efforts of the various fields of natural and social sciences. This union of expertise leads to scientific breakthroughs that can quickly be put into practice and be incorporated into education. This is the Wageningen Approach.

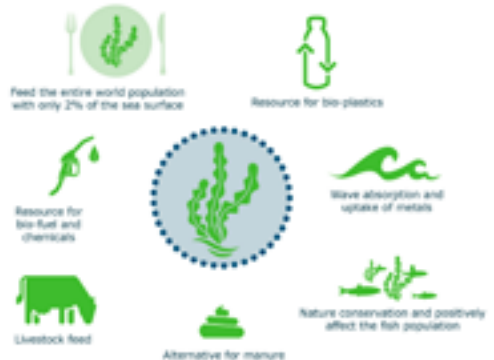
A photograph of a beach scene. In the foreground and middle ground, there is a large, messy pile of seaweed washed onto the sand. The seaweed is dark green and brown, with some lighter green strands. In the background, the ocean is visible with white-capped waves breaking onto the shore. The sky is a pale blue.

Seaweed cultivation

Packed with protein, carbohydrates, fatty acids and vitamins. Grows rapidly and in large quantities. Offers large amounts of protein without significant problems to the marine environment.

Agriculture at sea? Together with MARIN, TNO, Deltares and ECN, Wageningen University & Research is working on the sustainable expansion of seaweed production at sea. By optimally utilising natural and ecological circumstances the production of seaweed is stimulated and augmented, producing not only food but also feed, bio-chemicals, energy and other valuable products. As seaweed grows fast and in large quantities it is an ultimate opportunity of producing protein at sea, all over the world.

Possibilities of Seaweed



Sustainable Fisheries

30% of world's fish stocks are overfished; 60% fished at maximum levels. With innovations in fisheries practices and in management fish yields can increase, feeding more people.



Unwanted by-catches, unselective fishing, failing fisheries management; Wageningen University & Research together with partners world-wide and in close cooperation with the fishing industry is doing research in how to increase effective, efficient and sustainable fisheries increasing fish catches and at the same time increase fish stocks. This can be done by fishing gear innovations but also through innovations in fisheries management such as co-management. So more fish in the sea and also more fish available to feed the world.



Building with Nature

Coastal defence for safety, food production & sustainable livelihoods. 3D use of the coastal zone.



In many coastal areas world-wide the communities suffer from extreme poverty, coastal erosion en flooding, aggravated by climate change. Coastal defence by solid dykes is often too expensive. Wageningen University & Research together with Deltares, Royal Haskoning DHV, Solidaridad and the University of Bangladesh developed a system of oyster reefs and mangrove forests as an alternative to expensive coastal defence systems. These also provide opportunities for food production and sustainable incomes for local populations by means of oyster production, fishing and shrimp and fish farming. In addition, carbon is fixed in mangrove forests, thereby alleviating climate problems due to carbon emissions. A best possible solution fitted to local conditions and needs, increasing safety and food availability.




Halophytes for food

Leaves packed with a broad variety of vitamins, antioxidants and polyphenols. Seeds rich in oil and proteins. Extremely salt tolerant and grow rapidly with saline water or in full strength seawater. Offer opportunities to bring marginal saline grounds to high economic value



Increasing soil salinization and growing scarcity of fresh water worldwide dictate the need for domestication of inherently salt tolerant plant species with economic value. Wageningen University & Research together with other research centres, agricultural companies, farmers and governmental organisations developed guidelines for optimal farming of different halophytes in the Netherlands and in arid zones, evaluated the possibilities to integrate halophyte farming with fish farming, explored the potential to enhance the nutritional and pharmaceutical value of halophytes and studied its economic feasibility. Several halophytes are very promising future sources of leafy vegetable, feed and functional food.



A photograph of a pond covered in a dense layer of green duckweed. The pond is bordered by a blue tarp. In the background, there are several banana trees and a lush green hillside.

Duckweed, the smallest flowering plant on earth.

Floating on water and containing high levels of protein, vitamins and minerals. Can produce 10 times more protein per hectare than soybean due to its exponential growth. Does not need agricultural land use and is easy to harvest.

With the growing world population and the increase in meat consumption we encounter a huge plant protein demand. One of the solutions could be a new aquatic protein crop: Duckweed. Wageningen University & Research together with Hivos and Indonesian universities is testing the use of duckweed grown at smallholder farmers for feed purposes. Duckweed grows in small ponds at the farms on slurry from a bio-digester and is used to feed the cattle, fish or ducks. Wageningen University & Research is also testing the use of duckweed for human nutrition in Europe funded by the Wellcome Trust Foundation. This smallest flowering plant can help to feed the world with less land use.



Wasted fish saved

Fish is an essential source of protein in Africa. However, much fish is lost to spoilage in the sea ports because it cannot be preserved in time. In partnership with business, Wageningen researchers have developed a cheap and energy-efficient technology for drying fish.



The technology works by drawing cool, very dry air over the fresh fish so that nutrients and quality are preserved. The fish that would otherwise be lost can be transported far into the African interior as a welcome addition to the diet. The drying machine was developed as part of the European research programme Securefish. In this programme, researchers from several European countries, together with researchers from Namibia, Kenya and India are developing technologies to prevent wastage of fish.




Efficient and hygienic slaughtering

The world's aquaculture sector has been growing rapidly over the last decades and is expected to do so at least until 2025. Converting live farmed fish into high quality and safe food is a challenge for the sector.



The first step in efficient processing of live farmed fish boils down to efficient and hygienic slaughtering. In essence, a high-quality slaughter process entails stunning and killing of farmed fish, as this process is efficient, improves working conditions and can be controlled well with regard to food safety. During the past 10 years Wageningen University & Research has been collaborating with various slaughterhouses, manufacturers of slaughter lines and large supermarkets in Western Europe to set up slaughter processes or improve current ones.

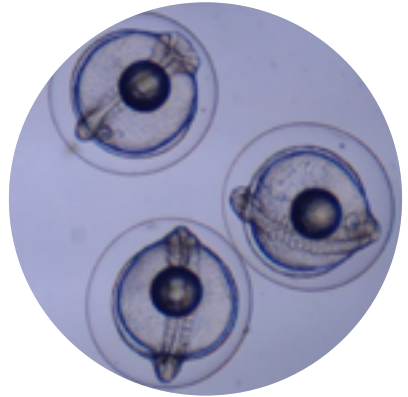


A close-up photograph of an eel's head, showing its large, prominent eye with a dark pupil and a golden-brown iris. The eel's skin is dark and textured, and its mouth is slightly open, revealing a pinkish interior. The background is a light, textured surface.

Closer to eel reproduction in captivity

World-wide, eel populations have decreased strongly since the 1970s. The existing eel farms still depend on the catches of glass eels in nature which are then raised to market size. Only a restricted number of glass eels is available for aquaculture and societal concern exists about the lack of sustainability

Successful reproduction in captivity could supply aquaculture with glass eels and close the production cycle. This way, both eel aquaculture as well as management of the natural populations could become sustainable. Several European research groups work independently on the reproduction of European eel in captivity but progress is still limited. By initiating the Eel Reproduction Innovation Centre (EELRIC), Wageningen University and Research and the Stichting Duurzame Palingsector Nederland (DUPAN) provide a platform for the reproduction of eel in captivity. It functions as a home for an international consortium of partners sharing experience and collaborating to force breakthroughs. The launch of EELRIC represents an essential step towards reproduction of eel in captivity to support sustainable aquaculture.



Sustainable food production in Indonesia

Fish and fish products are essential elements of the Indonesian diet and important factors in food security. As productivity is declining in capture fisheries increased availability of fish and fish products should come from reducing post-harvest losses and increased production of freshwater aquaculture.



The Indonesian government and Wageningen University & Research joint forces in the Fisheries and Aquaculture for Food Security in Indonesia - project. The project aims at improving sustainable food production in Indonesia and looks for ways to reduce post-harvest losses in the capture fisheries value chain and increase freshwater aquaculture production through improved technologies and inputs. Wageningen University & Research teaches the local staff to achieve this via interactive workshops and inspections on the site.




Healthy aquaculture

Aquaculture can produce fish, shellfish, and crustaceans for consumption in a sustainable way, in fresh- and marine waters, onshore and offshore. However one of the major threats to intensive aquaculture is the occurrence of infectious disease outbreaks.



Disease outbreaks in intensive aquaculture can occur as a result of transport of live infected fish between farms, that might cause severe morbidity and mortality and as such threaten food security and incur high economic losses. Wageningen University & Research has expertise on global diseases of fish, shellfish, and crustaceans in aquaculture, and performs accredited and fast diagnostics to support aquaculture and prevent further outbreaks. Moreover, our epidemiologists analyse risk factors and disease transmission mechanisms of aquatic pathogens to reach effective prevention, targeted surveillance and monitoring, and optimal control strategies for aquatic diseases. With this, Wageningen University & Research supports the requirements needed to feed the world.



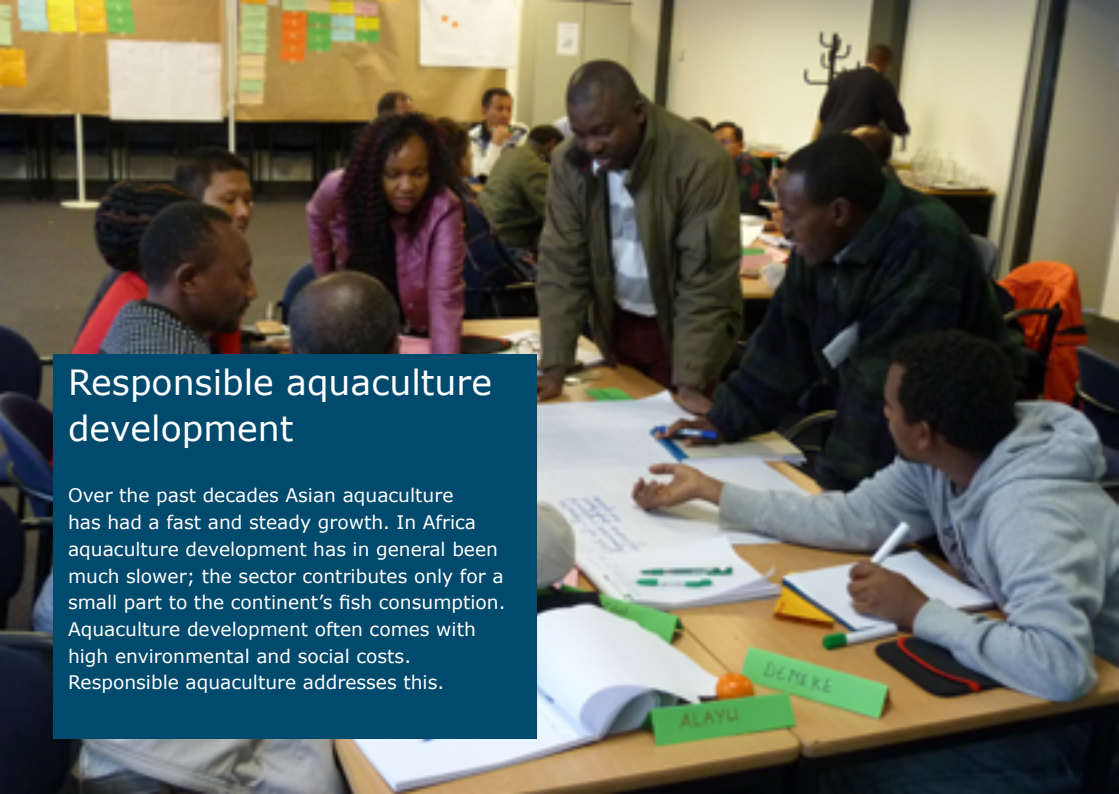


From vessel to plate, from pond to plate

In Asia aquaculture has seen a fast and steady growth recently. This often comes with high environmental and social costs. But at the same time is source of food and income to many.

Fisheries and aquaculture play a vital role in Indonesia. Both in terms of sources of cheap animal protein and micronutrients, as for direct employment of more than six million people, with well over half depending on marine capture fisheries for their income. With the Indonesian Ministry of Marine Affairs and Fisheries and NVWA, Wageningen University & Research partners aim to contribute to increased availability and accessibility of safe and good quality fish products in Indonesia by improving the performance of the entire capture fisheries value chain ("from vessel to plate") and aquaculture value chain ("from pond to plate").





Responsible aquaculture development

Over the past decades Asian aquaculture has had a fast and steady growth. In Africa aquaculture development has in general been much slower; the sector contributes only for a small part to the continent's fish consumption. Aquaculture development often comes with high environmental and social costs. Responsible aquaculture addresses this.

Wageningen University & Research develops capacity to raise fish in a more environmentally friendly manner. In short courses participants learn to apply the ecosystem approach to aquaculture as developed by FAO and are trained to prepare aquaculture area management plans as a way to address social and ecological issues that affect all producers of a catchment area, lake or bay. By training aquaculture professionals in techniques applicable at farm level that lead to more environmentally responsible production, Wageningen University & Research, together with FAO's Fisheries and Aquaculture Resources Use and Conservation Division, contributes to the development of a sustainable aquaculture sector.




Organising the market to increase food security

The EU's Common Fisheries Policy (CFP) and Common Market Organisation (CMO) aim at more responsibility for the private sector in fisheries governance. Bringing the decision-procedures closer to the producers of fishery and aquaculture products improves the sustainable management of a common resource.



Turkey, as accession country to the EU, is harmonising its own legal framework with EU's CFP and CMO. Since early 2000, Wageningen University & Research, together with many other EU partners, is working with the Turkish Ministry of Food, Agriculture and Livestock on increasing fish catches by improved conservation of fish stocks and on enhancing the quality of fishery and aquaculture products and their value chains by better organisation of the market. This offers opportunities for Turkish producers to line up fishery and aquaculture production with market demands, open up new (foreign and domestic) markets and address the need to feed a growing Turkish (and global) population.



A large offshore oil rig with yellow and white structures, featuring cranes and complex piping, situated in the middle of a blue ocean under a bright blue sky with scattered white clouds. The rig's legs are visible in the water.

Multi-use of space at Sea: facilitating and stimulating sustainable blue growth

As we are pushing more activities out at sea, such as renewable energy production and crop production such as seaweed, it is getting crowded. Especially in the coastal zone. How can we use this space more optimally?

Wageningen University and Research has several partnerships (in projects such as Mermaid, Maribe, Blauwdruk, Triple P at Sea) in which the uptake of new sustainable business opportunities to unlock the potential of multi-use of space at sea is facilitated. This is done in cooperation with a diversity of partners such as investors, government and industries. Partners develop innovative combinations of production of, for instance Marine Renewable Energy, Aquaculture and Marine Biotechnology. Also, the governance of this new co-use of space is a big challenge Wageningen contributes to. This work is highly relevant for the long-term EU Blue Growth strategy to support sustainable growth in the marine and maritime sectors as a whole.





Optimising space at sea

Wasted space. Can't we use the space in between windmills? Wind parks at sea take up large areas. Usually other activities are very much restricted in these areas. But let's use this space for food production.

Wageningen University & Research explores together with Dutch government, feed and fodder industries and start-up companies the viability of producing seaweed and mussels within marine wind parks. A lot of challenges need to be addressed and Wageningen is a pioneer in gathering all this knowledge. Besides testing what is the best way to produce the species under harsh circumstances at sea, research is done on chain development, new rules and regulations, safety and ecological aspects. Multi-disciplinarity is key to this type of innovative research.



A large school of silver fish with yellow eyes swimming over a coral reef. The fish are densely packed, moving from the upper left towards the lower right. The background is a clear blue sky, and the foreground shows the textured, brownish-orange coral of the reef.

REEFolution

Tropical coral reefs are among the most productive and biodiverse marine ecosystems on earth. They provide food and coastal protection to millions of people. But over-exploitation, global warming and other stress factors have caused a worldwide decline in coral reef condition.

Reefs provide local people with seafood and economic opportunities such as ecotourism. Degradation of reefs diminishes this. Therefore Wageningen University & Research started a coral reef rehabilitation project providing scientific insights for optimising restoration of damaged reefs and creation of new reef areas. Scientific research on coral reef ecology and active rehabilitation activities go hand in hand with outreach and education, in order to raise awareness among the local communities and help them prepare for a sustainable future. In Southeast Kenya these activities of Wageningen University & Research are in collaboration with the recently established REEFolution Foundation, the Kenyan Wildlife Service and a local ecotour operator Pilli Pipa.



Nutritious system pond farming to produce quality seafood

Most present intensive feeding systems for pond aquaculture of fish and shrimp result in a low protein use efficiency and high waste production. These systems assume that the cultured animals do not use the natural feed produced in the pond.

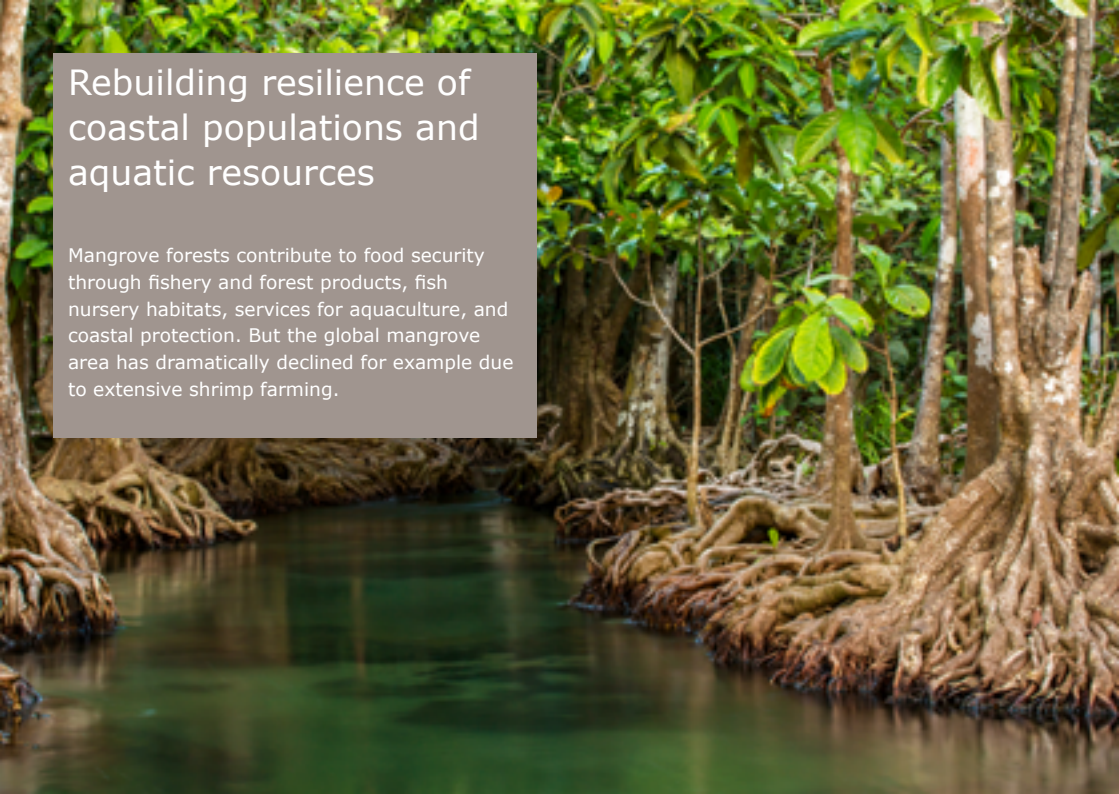


Wageningen University & Research is designing a 'nutritious-system' pond concept that exploits the potential of the pond ecosystem to mineralize wastes and produce natural foods. The 'nutritious-system' concept stimulates microbial mediated mineralization of wastes in the pond and the production of high quality natural feeds that can contribute to shrimp and fish feeding. Nutritious-system-feeds will lower production costs, reduce vulnerability and reduce environmental impacts from pond aquaculture.



Rebuilding resilience of coastal populations and aquatic resources

Mangrove forests contribute to food security through fishery and forest products, fish nursery habitats, services for aquaculture, and coastal protection. But the global mangrove area has dramatically declined for example due to extensive shrimp farming.



Wageningen University & Research, with partners studied the resilience of mangrove ecosystems, coastal fisheries, shrimp culture and associated diseases and the decision making processes at different socio-political and spatial scales. The RESCOPAR project developed decision support tools. These tools can assist policymakers in decision-making that considers the value of the coastal living resources for the local livelihoods and economy, and thus contributes to sustainable aquaculture of among others shrimp and the conservation of biodiversity and natural resources.



Closing the yield gap: increasing survival and production efficiency in smallholder aquaculture production of Nile tilapia

Aquaculture is the most rapidly growing sector in animal production, with a large diversity in species and production systems. Tailor-made breeding programs help to sustain this rapid growth by matching breeds with farming practices. This helps to ensure that the yield gap, the gap between potential and realized yield, is minimized.



Nile tilapia is the most farmed tropical fish species in the world and an important source of animal protein in developing countries. Most of its production is realized by smallholder farmers. However, many tilapia farms underperform in terms of survival and production efficiency, despite the use of genetically improved strains of tilapia such as GIFT. Together with WorldFish, and supported by the Koepon foundation, Wageningen University & Research works towards closing this yield gap, by developing tailor-made breeding programs to produce tilapia strains that match the production environment of smallholder farmers, contributing to increased food security from aquaculture.




Novel fish feeds

Fish culture is an opportunity to provide future generations with protein and essential fatty acids. Cultured fish requires good feeds. Enabling a global growth of aquaculture requires knowledge and innovations in fish feed production.



The growing human fish consumption can only be ensured by aquaculture. At the current yearly growth rate of over 7%, the fish feeds production needs to be doubled in the coming 10 to 20 years. Historically important fish feed ingredients like fish meal and fish oil are currently replaced by high quality plant ingredients. Wageningen University & Research together with other partners work on developing and applying new ingredients (algae, ragworm, insects) and valorising low quality feed ingredients from the human food industry for their application into fish feeds. These innovations should lead to sustainable fish feeds that do not compete directly and indirectly with human food production and provide nutritional well balanced feeds for fish.





Seaweed and natural capital

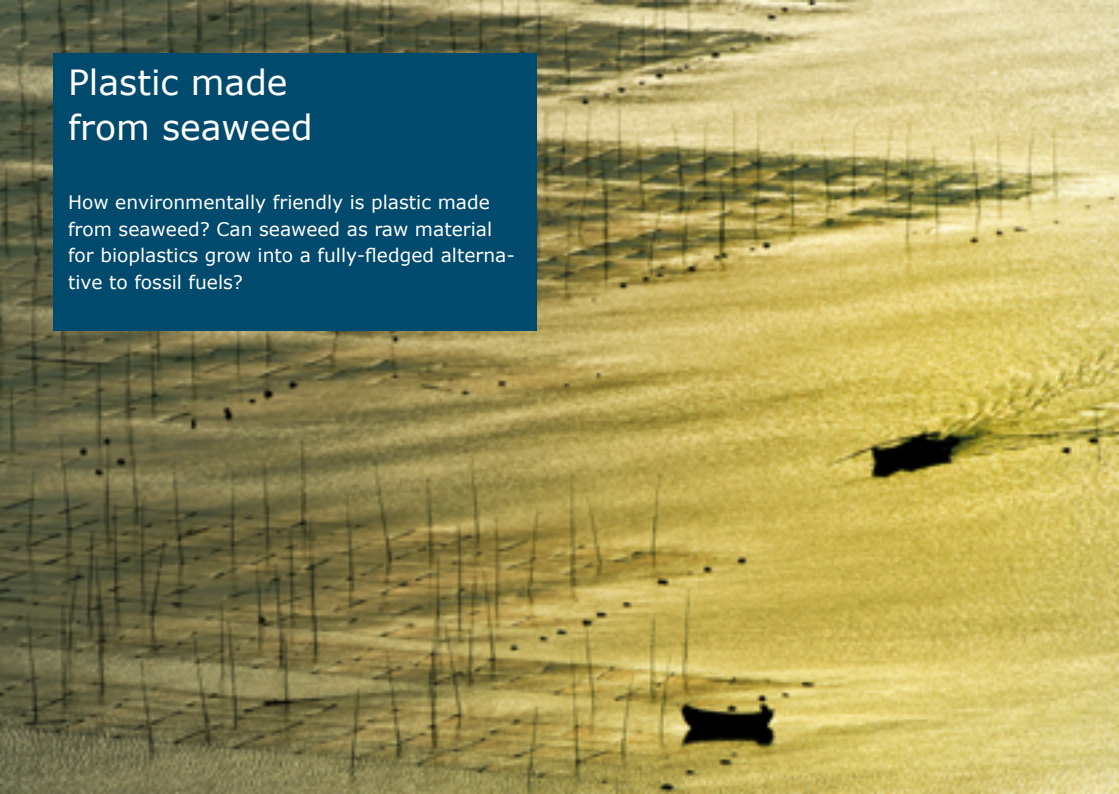
Large-scale seaweed cultivation in the North Sea is not yet profitable if only the value of the product - the seaweed itself - is taken into account. However, seaweed cultivation can provide a variety of beneficial ecosystem services.

By applying the concept of natural capital, it is possible to identify the beneficiaries of these ecosystem services and to engage them in discussions about the possibilities of evaluation and capitalisation. Whether a balanced business case for the large-scale cultivation of seaweed in Dutch waters can be realised depends on innovative forms of finance, assurance about the delivery of ecosystem services and applications of the produced seaweed.



Plastic made from seaweed

How environmentally friendly is plastic made from seaweed? Can seaweed as raw material for bioplastics grow into a fully-fledged alternative to fossil fuels?



Wageningen University & Research has analysed the environmental impact of making plastic from two kinds of seaweed. They did this by performing a lifecycle analysis already during the experimental phase, and concluded that using algae as biomass is fundamentally more environmentally friendly than using maize or sugar cane. Even so, there is plenty more progress to be made. The question, of course, is: can seaweed as raw material for bioplastics grow into a fully-fledged alternative to fossil fuels? A prerequisite is that we be able to make production economically viable. But there are also other factors, such as the impact of the production chain on the environment.





Aquaculture in the EAC

Potential aquaculture development for food security and income in the East African Community (EAC). Can we accelerate growth?

Aquaculture across East African Community (EAC) countries is a modest industry, and at the present speed of development cannot cope with the expected strong increase in demand for fish and fish products. Therefore, considerable effort is required in order to accelerate the development of aquaculture in the EAC. Among the main bottlenecks are the availability of high quality feed, access to investment and running capital, knowledge for sustainable high productive fish culture systems, and good quality fingerlings. A coordinated approach involving different public and private actors in the EAC region and from the Netherlands is essential in order to realise the aquaculture potential in the EAC.



A photograph of three children at a public water tap. A girl in the foreground, wearing a red shawl, is drinking water from her hand. A boy next to her is smiling at the camera. Another girl is visible in the background. The tap is a simple metal structure. The background is a clear sky.

Water resilience in the Himalaya

The Hindu Kush Himalayan region provides water to more than 1.3 billion people downstream and 210 million in the mountains. Climate change impacts the poorest and most vulnerable women, men and children in the mountains and plains of the glacier and snow-pack dependent river basins of the region.

To address priority adaptation issues in Pakistan, India, Bangladesh, and Nepal, The Himalayan Adaptation, Water and Resilience (HI-AWARE) consortium investigates the impacts of climate change in the Indus, Ganges and Brahmaputra river basins. HI-AWARE develops robust evidence on how to enhance the adaptive capacities and climate resilience of the poorest and most vulnerable people in the mountains and floodplains in the region.

The HI-AWARE consortium is led by the Nepalese Centre for Integrated Mountain Development and consists, next to Wageningen University & Research, of institutes from Bangladesh, India and Pakistan.



More information at

www.wur.eu/foodfromwater

