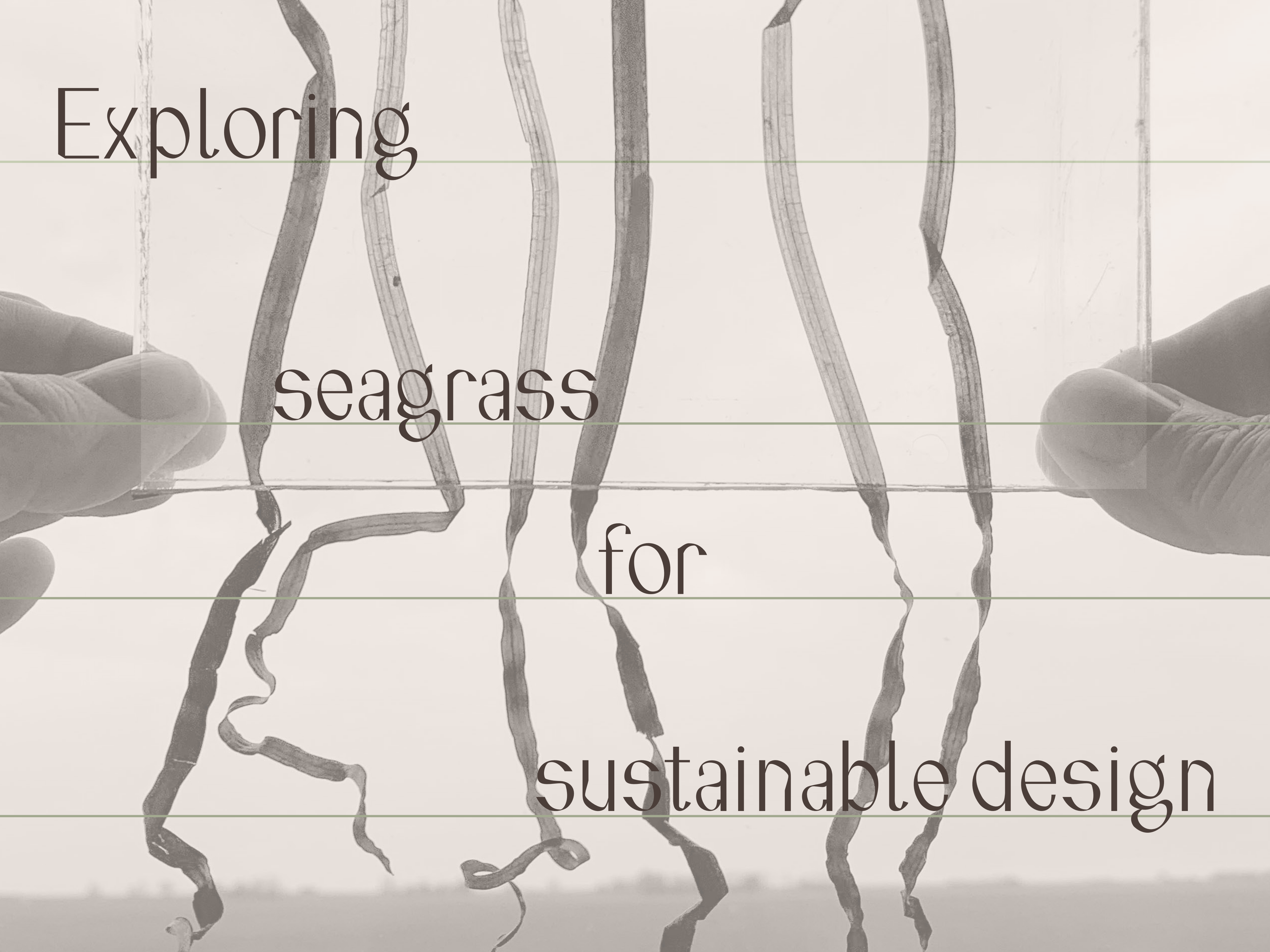
Exploring seagrass for sustainable design



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A water-rich future

NEW OPPORTUNITIES FOR AQUATIC PLANTS

Figure 1. KuiperCompagnons, visualization of ‘Pampus 2121. Living with water, city dykes and floating villages as a new urban form’, 2021.

Slowly but surely, more and more people are beginning to realize that climate change will have a drastic impact on life in the Netherlands. Scientists and designers have been trying to share their insights about this with the general public.
Jan Rotmans, Professor of Transition Studies and Sustainability, for instance, visualized a number of scenarios of the Netherlands in 2121, when large parts of the country will be underwater (fig. 1).[1]

Scientists from Wageningen University & Research (WUR) have also tried to visualize the distant future in the year 2120, when we will have to harness the new forces of nature that will present themselves as a result of climate change, in order to keep the Netherlands safe, healthy and prosperous (fig. 2,). The well-known Futures Cone (fig. 3) illustrates that perspectives on the future can differ enormously.
WUR scientists chose to visualize a possible, plausible and probable future in the form of a map. The map shows large bodies of fresh and salt water that offer new opportunities for 'aquaculture': cultivating oysters, mussels and seaweed. Seagrass, which thrived in the salty, brackish water of the Wadden Sea and the Zuiderzee, is not mentioned.

Before 1932, there were tens of thousands of hectares of seagrass in the Netherlands (*Zostera Marina* and *Zostera noltii*), which had formed an important source of income for fishermen since the Middle Ages. In the nineteenth century, the harvesting of seagrass was professionalized, and a whole industry sprung up around it: seagrass was used as filling for furniture, pillows and mattresses, for ship repairs, as building material for dykes, as well as for walls and roofs in houses, because of its fire retardant properties and capacity for thermal and acoustic insulation. Dutch seagrass was also used medicinally, for instance to treat rheumatism. The seagrass industry was brought to an abrupt end in 1932, when the Zuiderzee was closed off from the North Sea and

1 Jan Rotmans & Mischa Verheijden, *Omarm de chaos [Embrace the chaos]*, (Amsterdam: De Geus, 2021).

Figure 2. Map images of the Netherlands in 2120 from the research project 'A nature-based future for the Netherlands in 2120', Wageningen University & Research.

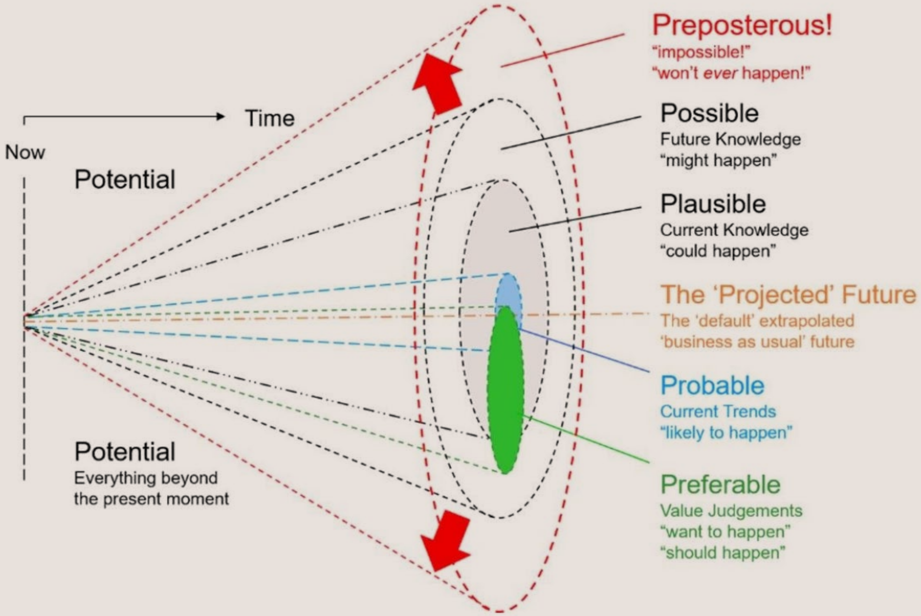

Figure 3. Joseph Voros' 'Futures Cone', 2017, showing alternative futures.

an epidemic infectious disease almost entirely decimated the seagrass meadows along the coasts of Western Europe and North America.

Conny Groenewegen en Marijke Bruggink had previously investigated the Dutch reed, rush and willow industry. These plants grow in fresh or brackish still water. They wondered whether seagrass, which grows primarily in salt and brackish water, had comparable or even better properties than the fresh water plants, and whether they could be used in new ways. Recent initiatives in Dutch, German and Danish coastal areas show that tentative experiments with seagrass have started up again. For instance, scientists are investigating whether it is possible to cultivate seagrass meadows to promote the ecological recovery of the Wadden Sea, with the aid of new restoration technology. In addition, there is a growing interest in the seagrass that washes up on North Sea beaches. It is currently still considered undesirable waste material for beach tourists, but scientists are looking into whether it can be used as sustainable building or insulation material, as organic fertilizer and as a potential new source of food.

The Professorship Tactical Design at ArtEZ University of the arts investigates design as a creative, communicative and integrative force for the transition to a sustainable society. The research topics include sustainable value chains for fashion, textiles and interiors. More and more stakeholders in the fashion and textiles chains see the importance of radical changes for a sustainable and circular economy. Natural, renewable raw materials and waste types from the agro-food sector challenge designers to develop products within circular and locally organized value chains. In this project, ArtEZ Tactical Design Professorship wanted to investigate, together with designers and students, whether new seagrass meadows, alongside the (increasing volume of) seagrass currently washed ashore, could be used for local, sustainable chains for textile products. Thanks to a KIEM subsidy from the National Fund for Applied Research SIA, we were able to investigate various angles of this question for a year. Under the guidance of Marijke Bruggink and Conny Groenewegen, and in collaboration with students from ArtEZ, Saxion and WUR, ArtEZ Tactical Design Professorship studied seagrass in scientific literature, in the lab, and in workshops. We worked together with Jolijn Fiddelaers (from what was previously known as IXX Creates), who designs sustainable textile products for various design labels. Our knowledge of seagrass grew thanks to The Fieldwork Company in Groningen, a company that has developed new techniques for restoring seagrass meadows in the Wadden Sea, and Horst Sterr, Emeritus Professor of Coastal Geography at Kiel University, Germany. He was a representative for Germany in the Intergovernmental Panel on Climate Change (IPCC) working group on Coastal Zone Management and involved in research on (washed up) seagrass.

Fatboy ⍨, the design label known for its beanbags, was interested in collaborating during the research. The company has embarked on a new sustainability strategy and sees potential in replacing their current polystyrene filling with sustainable filling made of renewable, natural raw materials. Polystyrene is one of the most common pollutants found in the sea, and styrenes are among the most damaging microplastics.

The central research questions under investigation in the project are as follows:

• Which local (Dutch and European) seagrass species have the right qualities for sustainable and ecological cultivation, harvesting and processing—possibly in combination with other sustainable resources—into raw materials for textile applications?
• What historical knowledge on the processing of fresh and salt water crops into products is (still) available and relevant for the development of sustainable value chains for consumer products?

To answer these questions, both theoretical research and material experiments were carried out simultaneously, where theory informed and inspired the experiments and the experiments challenged or confirmed theory. Due to the Covid-19 pandemic, with its lockdowns and travel restrictions, field research was unfortunately not possible.

The one-year research project consisted of various stages, and began by investigating which existing knowledge (historical, biological, cultural, etc.) on seagrass was available and relevant. Based on this, the next stage focused on two specific species of seagrass: *Zostera Marina* and *Posidonia oceanica*. The scope of possible applications to explore was expanded beyond the use of seagrass fibres and cellulose for textiles, because the plant's natural insulating, fire-retardant and anti-bacterial properties showed further potential.

Harvesting seagrass from the North Sea, like people did over a century ago, was not feasible, as it would damage the few vulnerable seagrass meadows that currently exist. Efforts are being made to restore wild seagrass meadows with cultivated plants, but this is only taking place on a small scale, and cultivated seagrass is not likely to become feasible as a commercial crop. Therefore, the decision was made to focus the material experiments on washed up seagrass leaves in the form of 'beach wrack' and 'neptune balls' from European beaches and to use only a few cultivated samples of seagrass for comparison. This further narrowed down and focused the research.

In the last stage of the research, materials, prototypes and use scenarios were developed together with ArtEZ Product Design students and alumni. This showed both opportunities and limitations for seagrass as a raw material for sustainable product applications. In this publication, we will share the most important insights and ideas we developed.

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Background

PAST AND FUTURE LINKED BY WATER

In 2020, Wageningen University & Research published an inspiring report: ‘A nature-based future for the Netherlands in 2120’, including a landscape map of the Netherlands. This map is not a blueprint, but a line of thought: it shows what the Netherlands could look like in a hundred years’ time if you focus on nature-based solutions. Phenomena such as climate change, urbanization and decreasing biodiversity, rising sea levels, extreme weather and increasing food production play an important role in determining spatial planning in the Netherlands. It turns out we feel the need to look at the bigger picture: what will the Netherlands look like in a hundred years’ time if you take these factors into account?

In the past there was a lively seagrass industry in the Netherlands (fig. 4, 5). Five hundred tonnes of long seagrass (*Zostera marina*) were harvested every year around the Frisian island of Wieringen. Because of its waterproof properies, dried seagrass was used to make seawalls. It was also used as filling for pillows and mattresses and as fertilizer for agriculture. There were thousands of acres of seagrass, which could be up to 1.5 metres long, in the Wadden Sea, but an infectious disease outbreak and the construction of the Afsluitdijk from 1920 to 1932 (which closed off the Zuiderzee, creating Lake IJssel) caused the seagrass to die off, and the industry around it disappeared.

Figure 4. Seagrass harvesting boats and dignitaries pose for photographer, 1900.

Figure 5. Arrival and unloading of seagrass in Den Oever, 1925.

What initially sparked Bruggink and Groenewegen's interest in the use of aquatic plants for textile was a visit to the Carpet Museum in Genemuiden. In Genemuiden, rushes were used to make mats as early as the sixteenth century. By the eighteenth century, the town had become central in the mat weaving business. At the time, there were about 150 hectares of rushes; by 1900, this had more than tripled. The rushes that were cultivated here were of high quality and were exported to nearby countries on a large scale. After the Zuiderzee was closed off, the quality of rushes on Lake IJssel coast deteriorated, as less silt was deposited because of the disappearance of the tides. Genemuiden recalls the history of a grass that was used as a raw material for traditional craftsmanship, a history that closely resembles that of seagrass. Bruggink and Groenewegen observed rush weaving in action—carried out by a handful of older volunteers, the only ones who still possess this near-extinct skill, which is threatening to disappear entirely in the Netherlands—and wondered whether a connection could be made with the use of seagrass as a raw material for textile.

Both designers also visited the National Weaving Museum in what used to be the State Reed Weaving School in Noordwolde. This school was established in response to the abundance of low-grade reed and willow as materials, which required well-trained craftsmen and designers for the development of a high-grade and highly profitable furniture industry.

The beautiful objects they saw were so appealing to the imagination that Bruggink and Groenewegen wondered whether they had stumbled upon a possible solution for the future, namely bringing back the cultivation of forgotten aquatic plants linked to a (new) technology, to see whether a less labour-intensive and higher quality method of processing was possible. Perhaps these plants could be used as textile fibres for thread or yarn, for instance. To put it differently: how can we bring together past knowledge of plants, raw materials and craftsmanship in the Netherlands and thereby anticipate a solution to an important problem in the future?

During the search for modern-day examples of woven products made of grasses, it turned out that many modern products claiming to be made of seagrass were actually made of terrestrial and freshwater grasses. It was partly because of this mix-up of names that Bruggink and Groenewegen, after a few meanderings, eventually came across the plant explored in this publication.

The designers were intrigued by these two stories: a Dutch local, ecological and economic history, and a vision of the future of our landscape, linked by water and possibly by seagrass. The latter is what we hoped to explore further.

The plant

ZOSTERACEAE AND *POSIDONIACEAE*

Seagrass is a seed plant with roots, comparable to terrestrial plants, which grows and flowers in salt and brackish water. The name 'seagrass' lends itself to confusion. Homeware shops sell products made of 'seagrass' that are not, in fact, made of seagrass, but of other materials, such as water hyacinth, and in popular speech, seagrass is often referred to as 'weed' or 'seaweed' (in Dutch: *wier* and *zeewier*). The former island of Wieringen, for instance, is named for the vast seagrass meadows that grew there before 1932. But scientifically, seaweed and seagrass are not the same thing, although they are related.

More science: seagrass isn't actually grass, but a vascular plant that has adapted evolutionarily to a life submerged in brackish and salt water. The name 'seagrass' also suggests there is only one plant species, while there are actually several seagrass families and a large number of different species. Turning to the scientific Latin names helps clarify matters. There are four seagrass families: *Zosteraceae, Hydrocharitaceae, Posidoniaceae* and *Cymodoceaceae*. In our research, we have focused on the species that thrive in the European waters of the North Sea and the Mediterranean. To add to the confusion of names, two of these species of seagrass are also known as eelgrass and dwarf eelgrass in English.

Growth and recovery of seagrass species

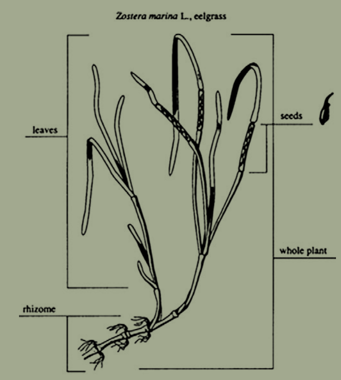
Two of the fifteen species of the genus *Zosteraceae, Zostera marina* (eelgrass) and *Zostera noltii* (dwarf eelgrass), grow on the North Sea coast of the Netherlands, Germany and Denmark (fig. 6). Some of the differences between the two include geographic range, harvest time and leaf size. *Zostera noltii* leaves are slim and don't grow longer than 25 centimetres. Dwarf eelgrass grows intertidally. Because it is uncovered at low tide, it can better withstand extreme changes in conditions, such as fluctuations in temperature and salinity. Dwarf eelgrass can be harvested from June to August.

Zostera marina leaves can grow up to one metre long and half a centimetre wide. There are two varieties of this eelgrass: the narrow-leafed, flexible kind is annual, and grows in the deeper part of the tidal zone—between the low and high tide marks. The robust kind grows deeper—from the low tide mark. This kind is perennial and does not remain uncovered for long at low tide, if at all. It is this robust kind of eelgrass that was used in the seagrass industry in the past. Until 1932, the Dutch Wadden Sea encompassed more than 15,000 hectares of seagrass meadows of robust *Zostera marina*. *Zostera marina* leaves that wash up on the coast can still be harvested along the North and Baltic Seas, in Germany in June and July, and in Denmark in September (fig. 7-12,).

Currently, seagrass is only harvested by removing washed up beach wrack along the coast, particularly in view of beach tourism (fig. 13, 14). This requires

Figure 6. Geographic range of *Zostera marina* (in yellow) (source: IUCN,).

Figure 7. Picture of *Zostera marina* on the seafloor.



Figures 8 and 9. Drawings of *Zostera marina*.

Figure 10. Seagrass meadow in Loch Craignish, Scotland.

Figures 11 and 12. *Zostera marina* from the marine garden near Cádiz.

a continuous balancing of economic and ecological concerns. Removing seagrass is expensive, but stimulates extra income through tourism. However, conservation of seagrass meadows and not removing washed up seagrass contributes to the ecological recovery of coastal areas and prevents coastal

Figure 13. A banquette of dead *Posidonia oceanica* leaves mixed with sand acts as a shoreline protection against erosion, Greece 2013.

Figure 14. Neptune grass (*Posidonia oceanica*), also known as Mediterranean tapeweed, washed up on the south coast of the island of Ibiza, Balearic Islands, Spain.

erosion. This prompted the research team to investigate ecologically and economically sustainable concepts for washed up seagrass. Recent initiatives in the German and Danish coastal areas shows that a new industry is developing: washed up seagrass is being used as building and insulation material, as organic fertilizer and as a potential new source of food.

Biologists have been trying to bring eelgrass back to the Wadden Sea since 1993, but that has only succeeded in part. Most seagrass can now be found in the northern part of the international Wadden Sea, in the lee of islands and sandbanks. Attempts to revitalize seagrass are not unequivocally successful. Perhaps these attempts came too soon, when there was not yet enough sense of social urgency. In September 2011, the Waddenvereniging ('Wadden Society') started a project that was to bring back the flexible kind of eelgrass to the Wadden Sea. The first results of the research, which The Fieldwork Company (TFC) from Groningen also contributed to, are hopeful. TFC was the first to manage to cultivate seagrass in saltwater tanks under controlled circumstances, and also developed a method to anchor young seagrass plants to the seafloor using 3D printed structures (fig. 15).

As a nursery, TFC is developing a roadmap for the long-term cultivation of seagrass, aside from the goal of restoration. They not only informed us about the features and ecology of the seagrass plant, but also supplied the research team with a quantity of cultivated wet and dry seagrass to use for the first material experiments. The question is whether the newly developed restoration techniques for seagrass only serve an ecological purpose, or if they can also—in line with WUR's envisioned future scenario—be used as a renewable source to satisfy our material needs. Not everyone agrees on this. TFC's Jannes Heusinkveld thinks his seagrass plant technology will primarily be used for sustainable, ecological goals, while the German scientist Horst Sterr by no means rules out the possibility that this technology will form the basis for a new sustainable, bio-based economy for seagrass.

For ArtEZ researchers, the latter is reason to consider new applications and accompanying business models for seagrass. This will build in part on earlier applications, but new innovations are also conceivable, thanks to the development of sustainable bio-based chemistry for glues and composites, for instance. This is particularly interesting for the construction industry: there is great demand for circular, locally sourced building materials. Hopes are that this will help further current developments in seagrass cultivation.

Figure 15. Seagrass cultivation at The Fieldwork Company in Groningen, 2021.

In addition to various *Zostera* species, seagrasses of the *Cymodoceaceae* and *Posidoniaceae* families also grow in the warmer waters of the Mediterranean Sea. For our research we used the *Posidonia oceanica* species (also known as Neptune grass or Mediterranean tapeweed), a seagrass that is dominant in the Mediterranean Sea and washes up on the shore in large quantities (fig. 16 and 17). *Posidonia oceanica* grows at a depth of 50 to 60 metres. The leaves are 20 to 40 centimetres long and are slightly wider than those of *Zostera marina*. The leaves wash up on the shore in autumn and winter. The dead leaves of this type of seagrass form natural bundles of fibre which roll themselves into balls over the seafloor and float up to the surface. These are known as Neptune balls (*aegagropiles*). Neptune balls wash up on the coast of Mallorca, for instance, and thanks to a helpful on-site contact, we were able to obtain some of these fascinating Neptune balls for our research (fig. 19-20).

Figure 16. Geographical distribution (solid green line) of *Posidonia oceanica* in the Mediterranean Sea.

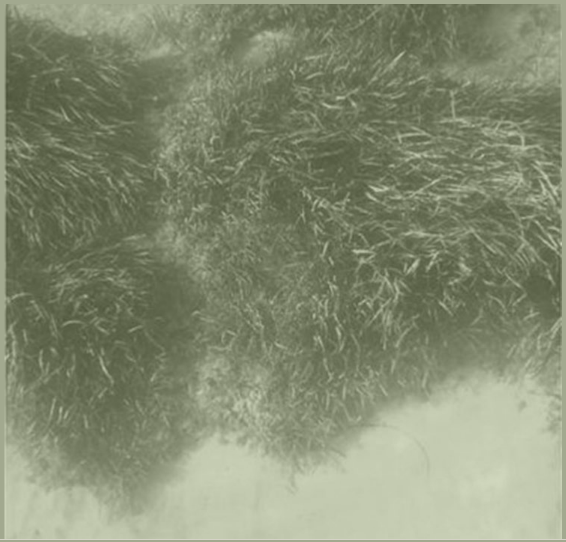


Figure 17. *Posidonia oceanica* in the sea.

Figure 21. Dried *Zostera marina*, used for our research.

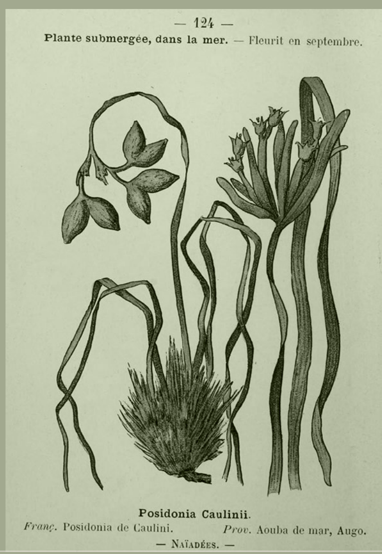


Figure 18. Drawings of *Posidonia oceanica*.

Figures 19 and 20. Neptune balls (*Posidonia oceanica*).

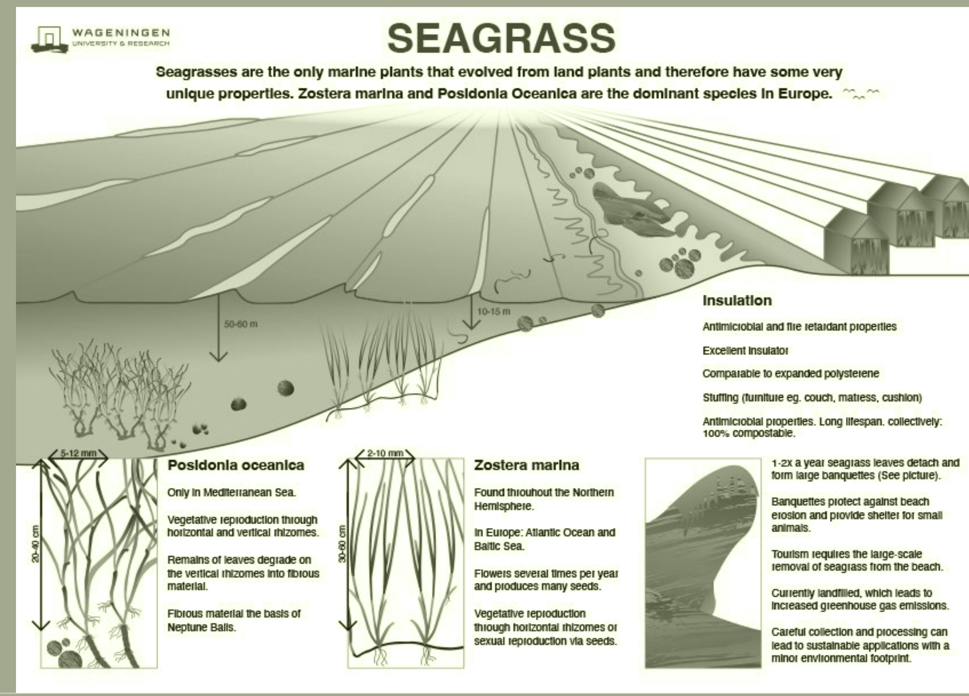


Figure 22. Features of *Zostera marina* and *Posidonia oceanica*, the two seagrass species in our research, visualized by Paul Hulsebosch based on a report, *Seagrass: Possible Career or Washed up?*, written by WUR students.

Sustainable uses of seagrass

FROM MATERIAL EXPERIMENTS TO STORYTELLING

Insulation and filling material

Seagrass is an important plant in delta areas because it helps prevent coastal erosion, stabilizes the seafloor and contributes to a rich biodiversity. Seagrass meadows serve as a breeding ground and shelter for various marine animals. In addition, seagrass can store a large amount of CO_2. A seagrass meadow of *Posidonia oceanica* can hold fifteen times more CO_2 per year than a comparable section of tropical rainforest in the Amazon.[2] This is exactly what we need, given the current climate and environment issues. But in addition to its valuable contribution to nature, can seagrass also serve an economic purpose again, to facilitate a socially and ecologically sustainable and locally organized industry? Given what we know of the Dutch history of seagrass and the distant water-rich future, what are the options for sustainable textile, for instance?

Throughout the centuries, people along the coasts of Northwestern Europe have used seagrass primarily for pragmatic reasons. As a relatively cheap material with a number of unique properties, it was used for dyke-building, roof thatching (often in combination with reed), thermal and acoustic insulation, stable bedding, filling for mattresses and cushions, and for stopping leaks in ships (fig. 23, 24).

Figure 23. 'Crindel', natural mattress by Lavital, 2022

Figure 24. Advertisement for upholstery with various types of filling, including seagrass, from Alkmaar archive, 1912.

Seagrass fibres aren't strong, but they are long and uniform in thickness, which means the material can be used for the applications mentioned above without sorting it first. The material does not need to be retted or pressed to be able to use the fibres. Thanks to its salinity, the material is mould-resistant as well as highly fire-retardant, which makes it suitable for use as (roof) insulation and filling material. Around 1900, Samuel Cabot Inc. in Boston developed a commercially successful product known as Cabot's Quilt: fire-proof insulation sheathing made of dried seagrass between two layers of paper for housing construction.[3] Seagrass is still used as thermal and acoustic insulation material. Søuld, a Danish start-up, recently developed sustainable acoustic panels made of seagrass from the northern coast of Denmark. The acoustic panels are based on hundreds of years of experience with seagrass as a traditional construction material on the island of Læsø (fig. 25). The insulation value is comparable to that of glass wool. The product (fig. 26) was awarded a Cradle to Cradle Gold Certification.

2 Matt McGrath, 'Climate change: "Forever plant" seagrass faces uncertain future'.

3 David Bozsaky, 'The historical development of thermal insulation materials', *Periodica Polytechnica Architecture*, 41, no. 2 (2010): p. 49.

Figure 25. *Zostera marina* leaves used as roof thatching for a historic farm on the island of Læsø.

Figure 26. Søuld's acoustic panels made of seagrass.

The use of seagrass for the applications listed earlier all but disappeared during the second half of the twentieth century thanks to the introduction of modern, often synthetic products that brought better results. Glass wool, steel wool and polyutherane foam, for instance, replaced seagrass as an insulation material. The introduction of polyether foam and HR foams has replaced the application of seagrass in interiors. At the time, this was tremendous progress, but where in the past seagrass was part of a circular, locally organized value chain, the same can certainly not be said of the modern replacement materials.

Medicinal applications and nutrients

The application of seagrass as stable bedding is also interesting. The fibre helps prevent laminitis in horses, for instance: the salinity has a medicinal effect and works as an anti-inflammatory. Seagrass was not only used medicinally for animals, but also for humans. Raw and cooked *Zostera marina* leaves were used to treat rheumatism. Many seagrass species have antibacterial properties and contain antioxidants that can eliminate pathogens.[4]

Seagrass contains nutrients that are not only useful for fertilizing land, but also as a source of food for humans. Some seagrass species have leaves and roots that are crunchy and sweet because they contain saccharine, which is 350 times sweeter than sugar. Scientists recently measured how much CO_2 was stored by seagrass meadows in the Baltic Sea and the Caribbean. In the process, they discovered a high concentration of sugars (sucrose or saccharose, our common table sugar), 80 times higher than previously measured in the sea.[5]

4 Joleah B. Lamb et al., 'Seagrass ecosystems reduce exposure to bacterial pathogens of humans, fishes, and invertebrate', *Science* 355, no. 6326 (2017): pp. 731-733.

5 Frank Rensen, 'Wetenschappers treffen bij zeegrassen verrassend grote ophopingen suiker' ['Scientists discover surprisingly large amounts of sugar in seagrasses'], *de Volkskrant*, Saturday May 7 2022, Boeken & Wetenschap, p. 3.

Figures 27 and 28. *Zostera marina* as a source of nutritious marine grain.

Zostera marina has also been embraced by chefs as a gluten-free marine grain with high omega-6 and protein levels that grows without the need for fresh water or (artificial) fertilizer (fig. 27, 28). Spanish chef Ángel León—as Marijke Bruggink and Conny Groenewegen discovered when they came across an article in the *Guardian* during their research—is determined to redefine the way we see the oceans. León investigated the *Zostera marina's* 'marine grain' and found a *Science* article from 1973 describing how the grain was an important part of the diet of the Seri, an Indigenous people that lived on the Gulf of California in Sonora, Mexico. The seeds of the seagrass were combined with cardón (*Pachycereus pringlei*) seeds, a cactus from the Sonora desert, to prepare festive and winter foods.[6] According to León, it is the only known case of a grain from the sea that can be used as a source of food for humans.

This seagrass species once grew abundantly in the bay of Cádiz, but had been reduced to an area of no more than four square meters. Therefore, Léon investigated the possibility of cultivation in a project together with a team from the University of Cádiz and researchers from the local government. They created a 'marine garden' in three small sections of one third of a hectare of salt marshes, and a year and a half later were able to harvest seagrass grains to use for experiments in the kitchen. Léon turned the grains into flour for making staples like bread and pasta, but also combined it with all sorts of flavours to recreate classic Spanish rice dishes.

In the article Léon says of seagrass grains, "It's interesting. When you eat it with the husk, similar to brown rice, it has a hint of the sea at the end, but without the husk, you don't taste the sea." Though similar to rice, the grain needs to be cooked two minutes longer and goes soft when overcooked. He also found that the grain absorbs taste well. Not only were the grains tasty, the plant proved to be beneficial for the ecosystem. All sorts of life, from seahorses to scallops, returned to the deserted salt marches and flourished.

Textile

Textile production has an enormous impact on the climate and environment. Therefore, there is an ongoing search for more sustainable alternatives for existing textile fibres and materials. Of course, the ArtEZ research team was very interested in whether seagrass could be used for sustainable textile applications. Recent scientific research as well as the research we commissioned from WUR and Saxion students shows that compared to similar plants, the cellulose content of seagrass is too low to make artificial textile fibres that resemble cotton and Lyocell.[7] Seagrass also doesn't contain a natural fibre (like linen or hemp) that is suitable for textile. It does, however, seem that a special seagrass species—*Cymodocea rotundata*—may be able to remove harmful substances like phosphorus and nitrogen from water that's used in textile dyeing.[8]

6 D.W. Irving et al., 'Anatomy and composition of *Zostera Marina* L.: A potential new crop, Ecology of Food and Nutrition 20, no. 4 (1988): pp. 263-274.

7 Peter Davies et al., 'Structure and properties of fibres from sea-grass (*Zostera marina*)', *Journal of Materials Science*, 42, no. 13 (2007): pp. 4850-4857; Nils Krister Persson, 'Textile as artificial nature: From synthetic sea grass to fibrous implants', *Advances in Science and Technology*, 100 (2016), pp. 181-186, .

8 D. Vasanthi et al., 'Phytoremediation to remove nutrients and textile dye effluent using seagrass (*Cymodocea rotundata*), *Advances in Biological Research*, 9, no. 6 (2015): pp. 405-412.

Design research

FROM MATTRESS FILLING TO SWEETENER

Figure 29. Documentation and conceptual starting points at the beginning of the design research.

The design research by ArtEZ Professorship Tactical Design is characterized by linking scientific knowledge to applied research, where the material is explored hands-on in the studio, in very diverse ways. The research is in no way limited to the properties of the material; instead, it also takes into account the possible ecological, societal and economic potential of any products and services linked to the material. This calls for an interdisciplinary approach where knowledge is brought together from various fields.

Research outline for 'the plant'.

	GROWING	LOCATION	SOCIAL - CULTURAL
terminology	- different seagrass species - harvest how - process - dry	- where does it grow in the world - mapping it - ecosystems - carpet museum	- climate effects / benefits - climate and environment - ecological balance - long-term perspective - **greenwashing**

Research outline for 'Making'.

TRADITIONAL		NEW TECHNIQUE (Tjeerd, students, Saxion, ArtEZ)		QUESTIONS
- spinning yarn - plaiting - weaving - knotting - filling	**other cultures** **other times**	- mixing with another material - mixing - pulverizing		- what is already being done - compare to other raffia/seaweed/flax/ applications - compare to other material, study
- insulation	**acoustics**	**OTHER TECHNIQUES**		**FIELD TRIPS** + students
- cushions - walls	**texture**	- pigments - smell - food - senses - architecture	**perfum** **top chef** **feeling** **expanding**	- Texperium - Brennels - Lavital - Tapijtmuseum - Germany, company for pillows with seagrass - Delft TU - Seaweed Girl

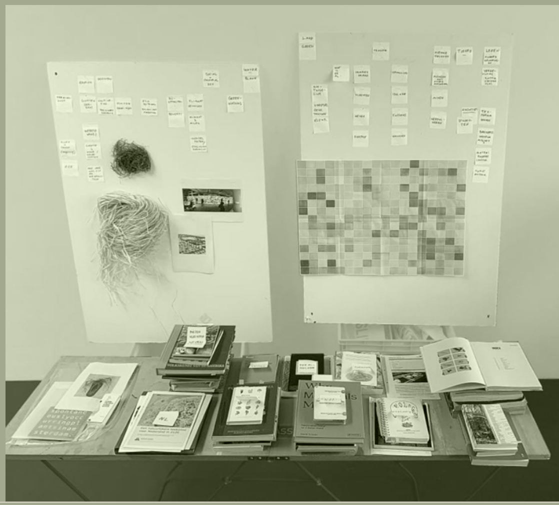
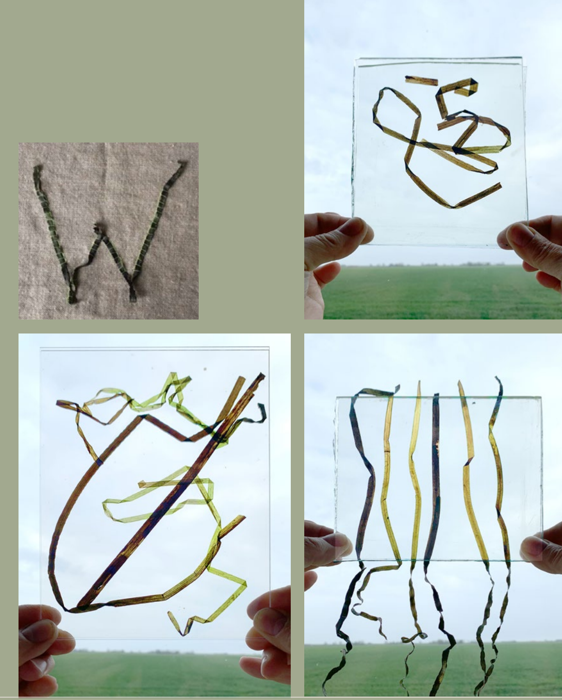


Figure 30. Documentation and conceptual starting points at the beginning of the design research.

Figures 31-33. Material testing with seagrass (*Zostera marina*): mixing with wool, spinning and twisting.



Figures 34-37. Material experiments with seagrass (*Zostera marina*): research on its aesthetic value.

This latter point was reason for ArtEZ Tactical Design Professorship, Bruggink and Groenewegen to link the designers' research on seagrass with three different student projects from Wageningen University & Research (scientific knowledge of seagrass), Saxion University of Applied Sciences (applied laboratory research and knowledge of business models), and ArtEZ University of the Arts (design-driven and experimental material-based research). Based on considerable preliminary research, Bruggink and Groenewegen proposed an outline to help the students in their research (see page 15).

Marijke Bruggink and Conny Groenewegen's studio research

What immediately became apparent in the research by the designers is the aesthetic, expressive qualities seagrass possesses. The rich range of colours and the paper-thin, elongated leaves are very seductive (fig. 34-37). As soon as you see it, you want to smell and touch it, hold it in your hands and squeeze it, only to give it air again and see it bounce back. Its qualities as filling material are immediately clear.

We spun rough wool from Texel sheep with the dried seagrass. The result was a yarn with a lot of structure. The grease in the wool and the torsion caused by the spinning were enough to secure the seagrass (fig. 31-33).

In terms of location, it's not inconceivable that wool and seagrass should encounter each other on Texel, for instance if a Texel sheep caught her wool on some barbed wire between the sheepfold and a potato field. Seagrass has been proven to contain nutrients that serve as an excellent fertilizer for potatoes, among other crops. In Germany this has already been put to the test, with good results.

We dyed a swath of Texel wool with a substantial amount of seagrass in boiling water, which resulted in various shades of brown (fig. 38-40). Much later in the process we boiled a sturdy and closely woven white cotton canvas (plain weave) in water with seagrass, which resulted in a comparable light brown colour with a greenish yellow undertone. The canvas became the cover of a large cushion filled with seagrass, to show that seagrass could be an alternative for the polystyrene beads currently used to fill Fatboy beanbags.

Figures 38-40. Material experiments with seagrass (*Zostera marina*): washing, picking, processing with glycerine, boiling and using as dye.

Figures 41-42. Material experiments with seagrass (*Zostera marina*): coiling, spinning and winding, mixing with latex.

Figure 43. Sack of seagrass arrives from Germany.

We washed part of the dried seagrass in water with 10% glycerine to see whether it would dry up softer and less brittle. This grass kept a slightly deeper, darker colour, but we were not able to establish (scientifically) a change in brittleness.

In our quest to find enough material for the students, we got in touch with Professor Horst Sterr from Kiel University in Germany. He and his research group Posima recently completed study on seagrass meadows and washed up seagrass on the Germany Baltic Sea. Their area of investigation was around Eckernförde, where about ten thousand tonnes of fresh beach wrack, mainly consisting of seagrass, washes up on the beaches annually, minimally contaminated with foreign substances. The beach wrack, known as *Treibsel* in German, is removed from the beaches at night with huge excavators for the benefit of tourism.

Posima has investigated whether the beach wrack would be suitable for all sorts of direct applications. For instance, the team studied whether beach wrack could work as a soil improver for the cultivation of potatoes and as a fertilizer. It turned out that seagrass lightens up the structure of the soil, which is good for moisture levels and root growth, and that seagrass nutrients can serve as nutrients for crops. The difference between Posima's research and ours is that the design perspective lies at the heart of our project, and informs how we look at the whole chain. In addition to his findings, Horst Sterr also shared two mail sacks of washed up seagrass with our team (fig. 43), which was extremely useful.

In addition to the *Zostera marina* from Germany, we also investigated the possibilities of the seagrass species *Posidonia oceanica* in the form of the aforementioned Neptune balls. While rooted firmly in the shallow Mediterranean seabeds, these plants sway in the currents, catching drifting bits of plastic. Nearly 900 million pieces of plastic per year may become entangled in seagrass leaves and Neptune balls, which eventually wash up on the shore, taking the plastic debris with them. In 2018 and 2019, the Spanish marine biologist Anna Sanchez-Vidal, from the University of Barcelona, carried out research on the amount of plastic particles in seagrass washed up on four beaches in Mallorca. Plastic waste was found both in loose seagrass leaf samples (up to 600 bits per kg of leaves) and in the Neptune balls. Not all the Neptune balls contained plastic (only 17%), but when they did, it was in a much higher concentration of up to 1,500 bits per kg. Knowing this, the researchers were able to calculate the amount of plastic waste that could potentially be filtered by loose seagrass leaves and Neptune balls in the area.

However, *Posidonia oceanica* in the Mediterranean Sea is also under severe threat from sunscreen chemicals that accumulate in seagrass. Scientists discovered ultraviolet filters in *Posidonia oceanica* stalks and think the pollution is due to mass tourism and the dumping of waste materials. Considering the Mediterranean is shallow, small and highly enclosed, the concentration of UV-absorbent chemicals can reach high levels. Although the full impact of these chemicals on seagrass is not yet known, the scientists are concerned about possible harmful effects. The sun filters could have a detrimental effect on the photosynthesis and productivity of seagrasses, for instance. Earlier research has already shown that certain UV-filtering sunscreens are harmful to fish, turtles and dolphins: their reproductive system and development are disrupted. Coral reefs are also affected, which has led to a ban on these chemicals in tourist hotspots such as Hawaii, Florida and Palau. Such legislation has not yet been adopted in the countries on the Mediterranean coast. Scientists emphasize the need for further research on the effects of UV-filtering chemicals in seagrass fields.

The student projects

Students and alumni from three different universities contributed to the seagrass research and worked together with our team in the last four months of the project. A group from ArtEZ Product Design focused on material experiments and use scenarios for seagrass. A group from Wageningen University & Resarch (WUR) did a literature study comparing the available scientific information about *Zostera Marina* and *Posidonia oceanica* and their properties. A group from Saxion University of Applied Sciences did laboratory analyses of seagrass samples to determine their cellulose content and antibacterial properties, while the other half of their group looked at sustainable value chains and business models. For all of the students, it was their first time working on an interdisciplinary research project like this. Though their approach and research focus (and timelines) differed, their combined efforts resulted in new understanding not just of seagrass, but of the value of combining applied, scientific and creative research.

WUR's ACT project

Biobased Sciences, Water Technology and Plant Sciences Master's students at WUR did their research as part of an ACT (Academic Consultancy Training) project, in which an interdisciplinary group of max. eight Master's students work on a real-life consultancy question. This is not the first time the ArtEZ Tactical Design Professorship has worked on a research project with WUR students. As part of a previous ACT project, WUR students studied whether it was possible to cultivate seagrass species suited for textile applications in the Dutch deltas, in such a way that it does not affect their biodiversity, or potentially even contributes to it. The conclusion was that a freshwater plant like broadleaf cattail (*Typha latifolia*) has more potential than seagrass. However, the research on seagrass in the first project was limited, so we decided to carry out further research.

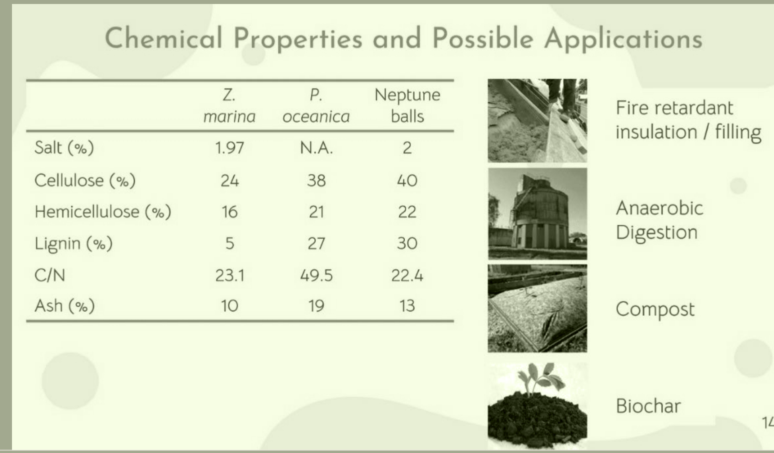
Figure 44. Results of chemical analyses by WUR students in relation to suitable applications.

The new ACT project focuses on *Zostera Marina* and *Posidonia oceanica*, which wash up 'locally' on European coasts: what are the ecological advantages of using these waste materials for new, sustainable value chains? The results were presented in an ACT report, with a literature review, data analyses, a stakeholder analysis and a report on interviews with stakeholders (mainly those at the beginning of the value chain, such as seagrass growers) (fig. 44).[9] The key findings concern the influence of local water and environment conditions in the areas where *Zostera Marina* and *Posidonia oceanica* grow on the seafloor. The biological, chemical and physical properties of seagrass depend, for instance, on dominant wind directions, tidal currents and seafloor properties.

Concerning the use of the washed up seagrass, students did not discover any substantially different applications than those already known from the past. One exception is the possible use of seagrass

9 A.J. Cepeda et al., 'Seagrass: possible career or washed up? Literary review on properties and possible applications of Zostera marina and Posidonia oceanica', ACT project Wageningen University & Research, 2021.

for the production of biochar, a charcoal-like substance that is made by heating organic material to over 350°C in the absence of oxygen. Biochar is currently of great interest for sustainable agriculture, because it increases soil fertility, decreases greenhouse gas emissions from soil and sequesters carbon in soil. The WUR students also concluded, however, that the use of (washed up) seagrass comes with challenges: its use is seasonal, and most likely a sustainable and circular chain is only feasible in local coastal economies.



	Z. marina	P. oceanica	Neptune balls
Salt (%)	1.97	N.A.	2
Cellulose (%)	24	38	40
Hemicellulose (%)	16	21	22
Lignin (%)	5	27	30
C/N	23.1	49.5	22.4
Ash (%)	10	19	13

Figure 45. Results of cellulose study by Saxion students.

Figure 46. Results of research on existing applications of seagrass by Saxion students.

Saxion's Smart Solutions

The group of Saxion students, working together as part of a minor in Smart Solutions, were asked to investigate the technical specifications of both *Zostera Marina* and *Posidonia oceanica* in the lab. Among other things, they looked at cellulose content, tensile strength in wet and dry conditions, and potential for processing into thread or fibre, possibly in combination with other sustainable materials. In addition, they were asked to consider applications beyond textile: could seagrass be used as a pigment for colour or scent applications, or as part of a composite?

The laboratory research at Saxion indicated that wild seagrass contains more cellulose than cultivated seagrass (fig. 45). The existing literature shows that *Zostera Marina* harvested from northern seas contains more cellulose than the same species in more southernly seas. This most likely has to do with the resistance the plant must offer to tides and other external influences. The cellulose content of glycerine treated seagrass is still about 47% lower than that of bamboo, and even 68% lower than that of cotton. Marine plants remain upright thanks to water in part, which means they need less cellulose and lignin. As yet, this means the seagrass we studied is unsuited to be used in textile. The cellulose content is sufficient, however, to allow processing into paper.

The Saxion students also concluded that there are already many contemporary applications for seagrass, but that most of these are not marketed on a large scale (fig. 46). Their advice is to shift the focus to already existing applications and to find the right markets and target groups for them. Start-ups, production companies and material designers should work together more for market-oriented research.

ArtEZ Fieldwork-programme

As part of the Fieldwork programme of the ArtEZ bachelor's degree in Product Design, three third-year students, two alumni and a lecturer took part in the seagrass research. The historical research formed the basis for developing concepts with washed up seagrass in various different fields, such as fashion, interior or architecture, for well-being and nutrition, and for a local community as a new kind marine farming. A classroom was reserved for participants to share results throughout the duration of the project.

Marijke Bruggink and Conny Groenewegen supervised the students in their research, with incidental support from Jeroen van den Eijnde, Jolijn Fiddelaers and Tjeerd Veenhoven. Bruggink and Groenewegen's role was primarily to steer, structure and stimulate, focusing on the students' own interests and ways of working. The students were given a great deal of freedom and responsibility during the project. Tjeerd Veenhoven brought in his knowledge of material properties and sustainable value chains. Jeroen van den Eijnde spoke about the wider context of sustainable design, which can focus on both concrete sustainable interventions in existing value chains, and creating

Figure 47. Miao Li, hands-on research on seagrass.

Figure 48. Miao Li, construction properties: brick, sheet.

Figures 49-51. Lisanne Peters.

consciousness about sustainability in society. Jolijn Fiddelaers shared her knowledge of sustainable textile production chains: what is your position as designer here?

Unfortunately, the project was hampered because there was not much seagrass available for experimentation. Due to the Covid-19 restrictions, our travel options were limited, which meant we could not collect (extra) material from Germany or Denmark. Our contact with the students as well as their experiments in laboratories and other specialist workplaces also suffered as a result of the restrictions. This means the results are small-scale and pragmatic; we had to work with what was available to us.

An example of this is the manual technique of making paper from seagrass with as few other ingredients as possible, based on boiling down, pressing and various coiling and binding methods (fig. 47, 48). Miao Li carried out various experiments with very few or no additions at all, other than heat, moisture and time to break down the lignin, subsequently compressing the resulting pulp.

Miao Li: *'In this project, my position and intention as a designer were to reveal various qualities of seagrass by working with a range of hands-on techniques. For instance, I cooked seagrass with alum and dyed several materials, which shows the dyeing properties of seagrass. By grinding and pressing seagrass in a mould, I made seagrass bricks that could be used in construction. By applying textile techniques to seagrass, it can be used for basketry or weaving. Those objects I made show several properties of seagrass, which allow us to think about the application context. They are also intended to help people appreciate its potential. Furthermore, this research can be shared with experts such as scientists, technicians, craftsmen, etc. From there we can dive into certain aspects and develop them further.'*

Lisanne Peters also illustrated the possibilities of seagrass, in her case with small-scale material experiments. She mixed unpicked and ground Neptune balls with plant-based binding agents to make a flexible composite foam that could potentially be used as a comfortable sole for shoes (fig. 49-51).

These experiments formed an interesting library of possibilities that showcase te beauty and potential of the material. The results could lead to further research.

Lisanne Peters: *'By using these Neptune balls as stuffing / a fibre ingredient, I was able to create a material that can hold itself together and is biodegradable and aesthetically pleasing, and what's more, it can act as foam. These properties allow Neptune foam to be used in many different ways, for shoes, mattresses, ottomans, etc. Do you see the possibilities?'*

Figures 52-55. Birgit Rijsmus, *The Hidden Beauty of Seagrass*.

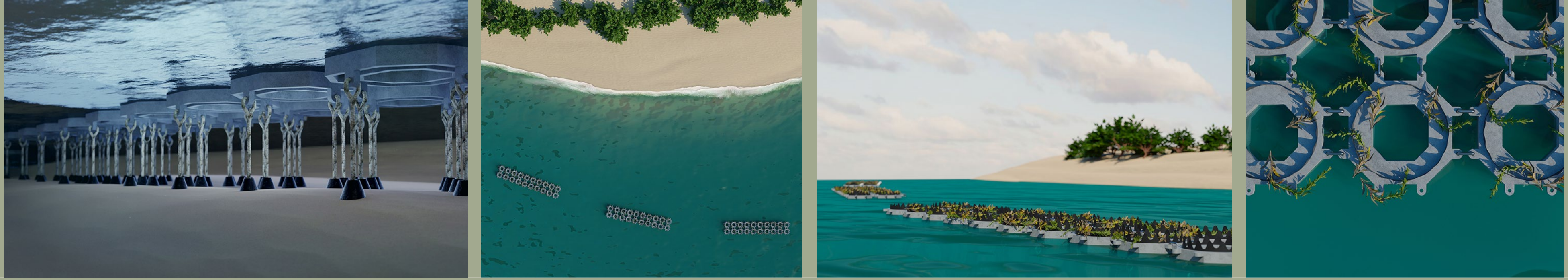
Figures 56 and 57. Birgit Rijsmus, The Hidden Beauty of Seagrass.

Figure 58. Visiting Fatboy.

One disadvantage of seagrass as filling between two layers of textile is that you lose the expressive value of the material itself. In her project, The Hidden Beauty of Seagrass, Birgit Rijsmus worked with semi-transparent textile, so that the seagrass filling claims its rightful position in the overall effect of the appearance of a textile object. The material thus contributes to one's understanding of the object, the origin of the filling and the wider narrative it forms part of (fig. 52-55). Rijsmus' work is like an open invitation to consider Fatboy's iconic products. It's not about functionality, but about expression.

The photos of her iconic scale models of the Attackle! Sofa, Edison The Petit lamp and a small beanbag, made of semi-transparent silk organza with a seagrass filling, force us to question the way in which we normalize these iconic forms, despite the imperfections of her remakes (fig. 56, 57). Rijsmus introduces an aesthetic that is clearly connected to the transition to ecological raw materials and minimal processing. The work addresses two target groups: Fatboy as a company, insofar as it goes along with Rijsmus' thinking as outlined below, and its audience of shareholders and buyers.

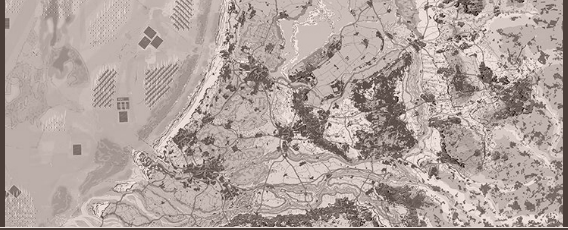
Birgit Rijsmus: *'Seagrass has been used as a filling material for mattresses, pillows, walls and packaging for ages. This means that seagrass has been around us for a long time, yet many of us are not familiar with it. Due to the specific properties of seagrass, the material is mostly kept out of sight. However, there is a certain beauty in seagrass that needs to be shown, because of how it looks, but more importantly because of the importance of using sustainable materials. I took Fatboy as an example, a company that is interested in working more with sustainable materials as filling. The very recognizable products that Fatboy makes don't necessarily radiate sustainability, which is something that needs to change if sustainable materials are to be used. By recreating some of Fatboy's most iconic objects in transparent fabric and filling that fabric with seagrass, I want to normalize an 'eco-look' for products, rather than trying to hide the origin of the materials used. These products are not meant to be used as an object to sell or produce, rather as statement pieces to let users know what material their new products will be made of and showcasing the beauty of what is inside.'*

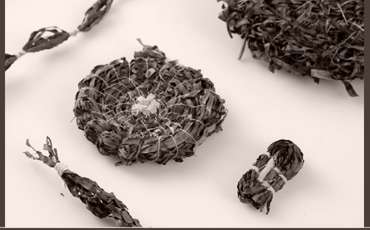


Figures 59-62. Paul Hulsebosch, photo montages of his proposal to use floating objects to catch seagrass off the coastline.

Paul Hulsebosch's project shows a broader perspective on the problem of washed up seagrass for the tourism industry. He proposes a series of floating objects that catch the seagrass and prevent it from washing up on the beaches. Essentially, he is killing two birds with one stone: the seagrass remains a valuable part of the ecosystem, and it's no longer necessary to clean up the beaches, which saves money and prevents ecological damage. The monumental design solution also brings the local public, including tourists, in close contact with the seagrass, thereby raising consciousness about its existence and value for the coastline (fig. 59-62).

Figure 63. Upon completion of the project, a small exhibition was organized at ArtEZ, where the students presented the results of their research.






Conclusion

Creative research with limitations

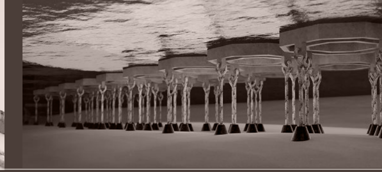
Just as tides and currents influence the properties of seagrass, so too this research was influenced by the waves of the coronavirus pandemic. What was to be a hands-on field and material study became, out of necessity, a project in which we had to work together remotely, while the material we were studying was only available in very small quantities. Luckily, creative researchers are better able to adapt to new conditions than seagrass is, and they proved (once again) that limitations don't have to be obstacles. The interdisciplinary collaboration between researchers, designers, entrepreneurs and student teams was particularly valuable and lead to cross-pollination. It was a considerable challenge to work together with so many groups of students and colleagues in such a short period of time, but together they mapped out all sorts of possibilities and lines of thought. Despite the short time-span and limited scope of this research project, it was nonetheless possible to gain a great deal of insight through reading, discussing, making and experimenting.

In the next few decades, because of the need to transition to a more sustainable way of life, there will be more and more demand for organic waste types. This holds for many sectors, but particularly those of construction materials, packaging and textile. Our water-rich future, as described by scientists, offers new opportunities for identifying, studying and evaluating these waste types. The ArtEZ Tactical Design Professorship anticipates this transition, and its research on seagrass is an excellent example of this. The collaboration between young designers still in training and experienced designers from professional practice resulted in a creative research project that offered scope for open-minded ideas that could immediately be tested against knowledge and experience. It underlined once again the importance of relatively small research budgets for universities of applied sciences to conduct open and experimental research. The SIA Kiem subsidy provided an excellent opportunity to do so.

Seagrass did prove to be a challenging type of waste. There was a complex mixture of limitations that soon had an effect on its creative divergence: there is not much left of its rich history, it is currently not widely available along local coastlines, it is protected to safeguard biodiversity, and has very limited mechanical properties. Solutions weren't exactly growing on trees. On the other hand, this research is being published at a time when there is renewed interest in seagrass: it is a potentially sustainable material with an enormous capacity for CO_2 storage. Scientists, designers, architects and cooks are investigating and experimenting with potential sustainable applications for seagrass in nutrition, textile dye, fertilizer and insulation. We were pleasantly surprised by the results of the project, in which students and professionals used good historical research as a basis for developing new, interesting perspectives.

Marijke Bruggink and Conny Groenewegen –the project's initiators–got a great deal of enjoyment out of their preliminary research, analyzing and planning potential avenues to explore in the project based on what they found about seagrass in books, articles, reports and online. Slowly they discovered that seagrass represents a world of stories. It's strongly linked to the history of seas and oceans, but also to local economy and manufacturing industry and to urgent contemporary questions about climate and biodiversity. The information they found confirmed the relevance of carrying out a project on seagrass, even though every outcome was uncertain.



With their preliminary research, Bruggink and Groenewegen provided the ArtEZ students with a firm, schematic basis for their own research. Looking over their shoulders, they learned from the students' process and from the new perspectives illuminated by their curiosity and tireless trial and error. It was a conscious choice to let them find their own application; Bruggink and Groenewegen took a step back as designers. Coaching the students, they tried to help them find their footing within the freedom they had been given, which was challenging for some.

A local future for seagrass

Conducting this research has convinced us of the importance of location and specific conditions when it comes to seagrass. Indeed, the growth and sturdiness of the plant differs depending on the location, the tides, the natural elements and human activities for production (and probably also sales). What crafts are available locally? What product can this result in? Is there a (local) market for it? These might be interesting questions for follow-up research. In terms of costs, it is probably most interesting to explore countries like India, which has a rich handwork tradition (with natural materials) and lower wages (though still fair and sustainable).

Seagrasses usually shed their leaves in the autumn and winter months. Due to the weather and high tides, seagrass piles up along the beach, which is generally seen as a threat to tourism. This brought a new question to our attention: what to do with all that washed up and unwanted seagrass? Most likely, a sustainable seagrass industry is only feasible on a local scale, as evidenced by the initiatives that are currently ongoing in Denmark and on the Baltic sea coast in Germany. Combining traditional applications with new techniques allows for a modern approach and design, as we already see happening in architecture. It is unlikely that seagrass will be used in the textile industry: as the literature suggests and laboratory research confirms, seagrass fibre is not strong enough.

Although recreating a sustainable value chain for Dutch seagrass does not seem feasible for the time being, seagrass leaves that are shed and wash up on European beaches as beach wrack and Neptune balls do speak to the imagination. As long as this seagrass is considered waste that pollutes beaches, any application that puts this material to good use is interesting, especially if it could potentially replace current non-renewable materials. In addition, this illustrates the importance of the narrative that exists about the material, because from an ecological point of view, there is no way that seagrass could be considered waste.

It was also interesting to see that the designers did not only approach seagrass as a raw material for products, but also investigated possible ways of harvesting and processing it. They also studied contemporary innovations, such as biocomposite, which didn't exist in the past. The collaboration with Fatboy was important because it was actually a very logical thought that this company might use a proven sustainable filling material like seagrass in its products. Even in such a short amount of time, the designers managed to show that these old techniques provide opportunities for modern applications too. It would have been wonderful if this part of the project could be extended, as we could also have focused on the antibacterial, antifungal and hypoallergenic properties of seagrass as described in the literature.

Scaling public awareness

In the seagrass project, Jolijn Fiddelaers was primarily drawn to two things: the natural aspects of the raw material (nature) and the current trend of looking for sustainable, local material and production methods (culture). As a textile designer, she has been working on the cutting edge of production and market since 2002, specializing in working with natural materials and handicrafts since 2010 (mainly in India). The question of 'what is ecologically healthy' is crucial to her, considering the fact that we were looking for (or looking to create) a sustainable cycle on many or all levels. Before diving into the technical possibilities of the material itself, Fiddelaers thinks it is key to look at overall scalability, since many choices on a design and market level are defined by this. For instance, a rare material that is available in small quantities defines design language (exclusive and distinctive), product category (small luxury products),




product branding (storytelling) and market positioning (high-end). In line with this, from what she understood previously and now, upon completing the research, she thinks that one sustainable solution for designers working with seagrass is to create (ecological) awareness. Even if it turns out that the material itself is too difficult/scarce to make commercially viable products with, it could very well serve a storytelling purpose. Even if the material is 'only' used as filling, one should keep in mind that scale depends on what is ecologically healthy, and harvests might not be stable throughout the seasons.

It seemed to Fiddelaers that the limitations of (healthy!) scalability might be difficult to overcome, so she was pleased to see how Paul Hulsebosch worked to keep the material in its natural habitat in his project, adding designed elements to upgrade seagrass from waste to a material with storytelling properties in order to create ecological awareness among beach tourists. This way one avoids the inevitable challenges that arise when a designer creates a product that has to be scaled and marketed in order to become profitable. We are curious to see how Paul Hulsebosch's monumental landscape designs will further take shape. How will his idea be received on the Baltic Sea coast? Can he pursue and implement his project there? We know that Horst Sterr, the German scientist who supplied us with relevant information and seagrass samples, will be ready to encourage him.

Another example of an instance where seagrass is used for a storytelling purpose is in Birgit Rijsmus' prototypes for Fatboy. Again it is not the actual user product that needs to be scaled (to be commercially viable), but the story it tells. For Fiddelaers, a good design concept for seagrass either tackles scalability and profitability or avoids it completely, by not intending to enter the market, but instead, for instance, maximizing its storytelling qualities to increase ecological awareness. Rijsmus seduces her audience with her photos of floating Fatboy icons: they are lightweight, almost mocking. Here, it's about the message that is told through the image, and which forces us to look at this icons differently. These are remakes that seem to enter into a different relationship with us, based on new rules of play, and it's up to us to discover them. Rijsmus is not looking for solutions; she wants to use her visual language to make us think about the things we find self-evident or natural. This creates openings for a conversation to take root. For a company like Fatboy, this could provide an interesting entry point for visualizing a different kind of future, together with its shareholders and customers.

We witnessed and read about interesting technique and material samples, exploring various production techniques. Of particular interest are the mixtures that allow you to use washed up seagrass (waste) to make new material, as shown in Lisanne Peters' research. She created a soft and flexible composite foam, perhaps as a starting point for an innovation in the shoe industry. Of course, additional materials or elements should serve to strengthen the sustainable/ecological qualities of the seagrass itself. One cannot just add chemicals or artificial elements to improve the material's properties. This has to be taken into consideration at the level of technique and production.

We also see potential in the traditional techniques Miao Li practiced, for instance compressing boiled seagrass pulp or coiling the rough, dried plant into a sturdy textile application. With Li's tenacity and refinement, this can result in well-designed, high-quality objects, which will upgrade seagrass 'waste' to a more exclusive segment of the consumer market.

Ultimately, therefore, one of the key concerns of this project was new ways of communicating about sustainability, which was explored to the full. This plant, which played an important role in our life with water in the past, and which could do so again in the future, primarily offers us, in the here and now, a point of departure for speculating about how we should design in order to reach our desired future, where both humans and seagrass can thrive.

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