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The complex interactions between humans and the marine environment require new efforts to build beauty and harmony

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Human activities give rise to many factors exerting tremendous pressure on the ocean and its coastal seas. Simultaneously, social, political, and ecological environments are highly complex, with many competing interests. Marine system management and governance must therefore integrate many perspectives incorporating human perception and behavior. Here, we discuss how philosophy and science often address the investigation of reality. The starting points are the atomistic and holistic views and their interrelationships. The distinction between particular and universal claims is added to the atomistic and holistic views and broadened to encompass the context; perspectives on processes and system insights into coastal seas are then analyzed. We conclude that an atomistic view risks fragmenting our knowledge and treatment of nature and humans into many separate and conflicting compartments, while a holistic approach opens up the "whole" but at the risk of oversimplification. The distinction between particular and universal claims is essential, and universal human values are critical for reversing the decline in the marine environment. Adding an increasing number of processes to sea management initiatives could risk reducing public interest and increasing alienation from the sea. Atomistic and holistic, particular and universal, or processual and systemic understandings should not be treated as contradictory; instead, our understanding of reality can be transformed when these complementary perspectives meet.

KEYWORDS

ocean, coastal seas, climate change, environmental change, perception, atomistic, holistic, harmony

Introduction

Perceptions of the marine environment often refer to reflections and speculations based on limited observations and knowledge. For most of human history, the sea was regarded as unknown and infinite, challenging explorers and imposing no limits on human activities. Later, after WWII, accelerated growth in many human activities started causing severe marine problems. We began shifting from conceiving the ocean as an unlimited resource free for all to explore and exploit for food, oil, and transportation, to understanding it as a limited and now endangered resource (e.g., World Ocean Review, 2010; World Ocean Review, 2013; World Ocean Review, 2014; World Ocean Review, 2015; World Ocean Review, 2017; Reckermann et al., 2022). Technical developments, often driven by the need for ships, navigation systems, satellites, and new instruments, have considerably improved oceanographic measurement methods over the last century. Simultaneously, globalization has increased the amount of available information due to new advanced communication technology and intense media competition. Still, there is a large gap between our scientific knowledge and our treatment of the sea. International management efforts have lacked cooperation and coordination across sectors, caused conflicts of interest, and lessened the prospects that actions to advance sustainability could be successful. Marine management must overcome multiple challenges simultaneously (World Ocean Review, 2021).

Sarmiento and Gruber (2006) notably stated that "biology has been described as the glorification of the particular, while biogeochemistry could perhaps be characterized as the exaltation of the general." Philosophy speaks of atomism and holism. An atomistic view argues that one must understand all the details to solve a problem. In contrast, a holistic view assumes that the system is more than its constituent details. In marine science, we often speak of processual and systemic understandings—two roads to a better perception of the marine environment. Many processes act in nature and society, ranging from chemical reactions to environmental law. How processes interact requires a systemic understanding of matters ranging from trophic levels in a marine ecosystem to human fish consumption. Here human perception, behavior, and decisions are closely connected and must be considered if we are to reverse the decline in the marine environment.

In this paper, we outline how philosophy has described the antithesis between atomistic and holistic thinking, which has been discussed since ancient times. The presentation should be considered an effort to include a broader view of human and coastal sea interaction to give complementary perspectives. The problem considered here is illustrated in Figure 1, with our perception of the sea often leaning toward processes resolved in increasing detail or systems considered within ever-larger contexts. For example, mapping marine genes versus estimating the marine carbon cycle. Another example is the ocean health concept. It is a metaphor paralleling human health

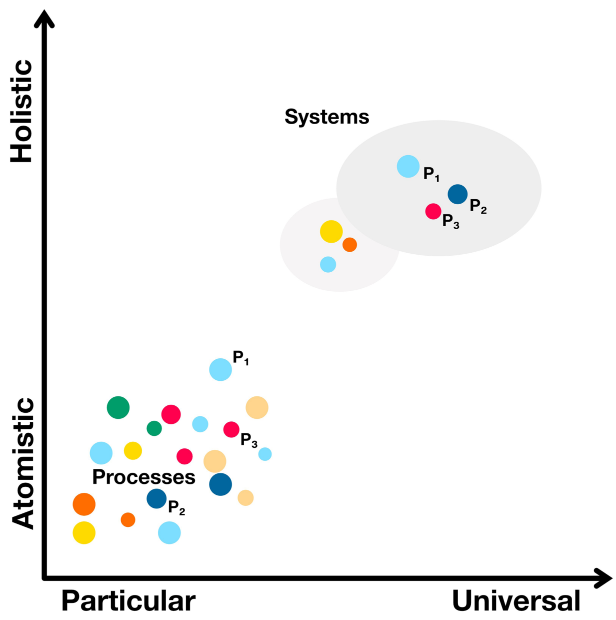

FIGURE 1
Sketch of the problem considered here, with circles indicating processes, some of which form parts of systems.

and is often ill-defined (Franke et al., 2020). At the same time, health is more holistic and has universal claims (e.g., Goal 3 in the United Nations 2030 Agenda for Sustainable Development, UN 2030 Agenda). Here science goes into detail when trying to operationalize the ocean-health framework. The universal/holistic and particular/atomistic relationships are examined and broadened to encompass a discussion of context. Then we review how a processual understanding of coastal seas has developed and how marine system insights have grown. A discussion then follows and, finally, a summary with some conclusions.

Atomistic-holistic views and particular-universal claims

Several dichotomies characterize western ways of thinking. These ways of thinking apply not least to what we touch on here, the concepts of atomism–holism and particular–universal. Though sometimes treated as equally significant, these terms differ greatly, having different denotations and connotations. Atomism means thinking about the individual parts of an object or phenomenon, while holism means seeing, thinking about, and reflecting on the whole. There is nothing between these poles: the concepts exist in an either/or relationship with no middle ground, being treated as complete opposites. Atomism tells us that the parts are independent of one another and constitute the basis for understanding the world. In contrast, holism tells us that the details of the whole are in such a relationship that they cannot exist independently of the whole or be understood without reference to it. The origin of holism is said to be Aristotle, while Jan Smuts (1926), the South African military leader and philosopher, is the one who coined the word in modern times. This view treats the whole as more significant than the sum of its parts. However, numerous examples in philosophical thought have attempted to merge elements of these two viewpoints in different ways, as Aristoteles did through the concept of phronesis. In marine research, atomism has dominated, especially in biology. This means that research has focused on seeking solutions to the perilous state of the oceans through gaining specialized knowledge of the various parts of the marine system. How then should we understand thinking about wholes? Let us consider a range of concepts concerning wholes. One way to access holistic knowledge is to organize research specifically to seek wholes. Thematic and project studies seek connections between traditional disciplines or subjects. Interdisciplinary studies, in contrast, are found worldwide and are often problem oriented, focusing on critical problems. Transdisciplinary research brings together many different fields to create a holistic view. Bringing disciplines and people together is a way for research programs to seek connections and combine different perspectives. A wealth of perspectives can conceivably provide both broadened and in-depth knowledge in a field.

Understanding how a coastal sea works requires knowledge of details, such as various marine species, humans, and their connections. If we regard contexts as holistic expressions, we can see ecosystems and coastal seas as constituting wholes. If we go further, we can see mountains, agricultural areas, the earth, or another unit as coherent wholes. These wholes can all be expressed as more than the sums of their parts—in other words, an entity or phenomenon is impossible to comprehend outside of its context.

The particular and universal form a pair of concepts with similar characteristics that have been described as mutually exclusive. The universal is also a "whole," i.e., that which applies in general. The particular can be expressed in terms of parts, such as atoms, long believed to be the smallest indivisible whole until we split them. This division between the atomistic (or particular) and holistic (or universal) was found in antiquity by Aristotle. The atom was posited as the starting point of the knowledge and truth of existence by Democritus (ca. 460–370 BC), in what is considered a precursor to the atomistic worldview of the Enlightenment. Zeno's paradox of the race between Achilles and the turtle was formulated in the mid-400s BC. By giving the turtle a head start, Achilles ensured that he would never catch up, because whenever he arrived at the turtle's current location, the turtle would already have gone a bit farther. The paradox was not solved until it was realized that a geometric series with infinite numbers could become finite. For example, the geometric series 1/2 +1/4+1/8+1/16+1/32+.where each successive term is obtained by multiplying the previous term with ½ becomes equal to 1 even for infinite numbers. If we assume that the turtle started 1 meter ahead, the difference in the distance become zero allowing Achilles to catch up. The mathematical solution was given by Isaac Newton and Gottfried Wilhelm von Leibniz in the 17th century (Ravanis, 2021).We may also look on Zeno's paradox as an illustration that going into more details will not help if a systematic, universal understanding is lacking.

A too detailed view might obscure the comprehension of a problem, a point also made by the saying "not to see the forest for all its trees." But there is also a recurring idea that we should see the whole in each element—hence, William Blake´s "to see a World in a Grain of Sand".

The relationship between the universal and particular is paralleled by how different thinkers have considered the concepts of the right and the good. The right can be regarded as universal, it applies to everyone and everywhere, and the good as particular, specific to different groups and cultures (Gustavsson, 2021). The relation between the universal and particular was discussed by Aristotle in terms of the concept of phronesis or practical knowledge. Phronesis concerns concrete things in their infinite variety. People must interpret each situation with the help of their pre-understandings, which are different for each person, i.e., particular, but that which is interpreted is universally available to every person for interpretation. Ricoeur (1988) expressed a second way of linking the universal and particular in the motto “a good life, with and for others, in just institutions.” A good life is here regarded as particular: people determine it differently in their concrete circumstances, but do so only with others, i.e., it is a social matter in which friendship plays a significant role. But the variations of the good have its limit in what is right in a universal sense, a moral limit that is universally determined. A third way is Arendt (1992) determination of political judgment based on Kant’s idea of aesthetic judgment. This means that an opinion emerges in public conversation, which Arendt describes as “visiting each other,” i.e., entering into the other person’s perspective, leaving one’s own, and thinking in general about what can be done for the whole and not essentially for oneself. Benhabib (2004) thinking is a fourth way of linking the universal and particular. She starts from the communicative conversation as the heart of democracy, but to have everybody participate, we must listen to their stories. Here, the power of good arguments, not tradition and authority, should be what governs. Linking concepts such as the universal and particular, or the atomistic and holistic, opens up many possibilities for new understanding.

The particular and atomistic are the individual parts of what we examine; the universal/holistic is the whole. The standard understanding of holism is that the whole is greater than the sum of the individual parts. If we prioritize the whole, we are expressing a holistic approach, and if we focus on the individual parts, we are describing something atomistically—“atom” being the common term referring to an individual component. The relationship between the individual parts and the whole is used and expressed in various fields, such as medicine, social science, physics, or biology. On the one hand, through an atomistic lens, we can explore areas of oxygen-free waters and go into detail about, for example, chemical reactions. On the other hand, eutrophication can also be described through a holistic lens, focusing on the effects on the whole system. The relationship between these two perspectives is obvious: without a deep understanding of the chemical reactions in anoxic waters, a systemic understanding will fail. Also, without addressing the effects on the system, the decline of a marine environment due to eutrophication will not be known.

Systems theory in the social sciences seeks connections between different levels, such as the macro, meso, and micro levels. It is an explicit way of finding context, of seeing phenomena and problems from a contextual perspective. Poetry, likewise flows from examples of how a grain of sand, a blade of grass, or another small part reflects the universe. Similarly, in what is called the “butterfly effect,” a butterfly’s wing beat can cause worldwide changes. The idea goes back to Lorenz (1963), based on instability of solutions to certain equations and initial conditions, relevant for atmospheric and ocean circulation. This illustrates that physical systems can become unpredictable to small “butterfly” disturbances.

A literary or musical experience contains a holistic experience. The climate can be said to create a whole, and the ocean is whole by definition.

In political philosophy, two opposite ways of tackling society’s problems reflect the atomistic and holistic perspectives. Many still set the atomistic Enlightenment against the holistic Romantic Era. Considering liberal ideology to be atomistic, Taylor (1995) is representative of communitarian thinking, which problematizes the view of the individual as free-floating in the body of society. People cannot survive without belonging to communities, such as the nation, church, or family, which are the wholes that situate them in context.

The fundamental question of what everything consists of characterizes the whole of pre-Socratic philosophy. The many proposed answers referred to the elements earth, water, fire, and air, but the concept of the atom ultimately won out. Universalistic thinking originated mainly in Plato, while contextualized particularistic thought originates in Aristotle, i.e., that the whole exceeds the sum of its parts. That something is contextual means that our way of thinking about it differs between societies and cultures. Similarly, humans can be described either as free individuals regardless of social affiliation or as social or political beings.

We can describe the problem of understanding the nature of reality in terms of two dimensions, with the atomistic and holistic constituting one dimension and the particular and universal the other (Figure 1). Then we can describe the types of descriptions and problems we encounter in the fields between these dimensions. Suppose that biology and biochemistry can both go in different directions, atomistic versus holistic ones. In that case, with ingenious combinations of these two dimensions, we can find new angles of approach for describing the state of the oceans. The holistic, which refers to graspable wholes, can be related to the universal approach that must be applied when considering the global state of the oceans. But this state can also be approached through the particular, in which we capture the individual parts of the whole. We can situate processual and systemic understandings relative to these two dimensions, showing that a systemic understanding often involves holistic and universal thinking; in contrast, processes are aligned with an atomistic, particularistic view.

Philosophy has characteristically been concerned with the relationship between the whole and its parts, and the atom has been the recurring theme regarding the precedence of the latter; this relationship has also shaped physical science. But there are recurring worldviews that claim the superiority of the whole in various ways. In recent times, the “holographic paradigm” was developed in quantum physics, based on the idea that there is a whole in the foundation of existence beyond time and space

(Wilber, 1988). A version of holistic thinking holds that a small part, or monad, can reflect the whole. The concept has ancient roots, but Leibniz shaped the modern philosophical view of monads (e.g., Grayling, 2021) as minor units that capture the cosmos or totality. Another version of holistic thinking is to see wholes as they are in themselves. In public education, it has been common to apply a holistic approach, for example, when studying astronomy or geography. Some streams of geography focus on connecting the individual continents or oceans. From another perspective, there are not several oceans; rather, they should be visualized as constituting one ocean connecting us all (World Ocean Review, 2021). If we broaden our approach, we can use the word context, which can be sought through exploring the connections between different parts. In a hermeneutic approach, one seeks to interpret the whole through an iterative cycling between details and context. In Aristotle's terms, we are social, or political beings, a view that conflicts with that of the atomistic, free-floating individual. Socio–economic issues can accordingly be analyzed in terms of social communities or free individuals.

If we go further, the term reductionism is sometimes used instead of atomism to refer to scientific claims to possess the whole truth about what is being studied. All sciences practice reductionism, for example, in their view of humans. Humans manifest physical behavior that, according to behaviorism, reflects laws that recall those of physics. Love, in these terms, could be described as the attraction of physical bodies, and the chemistry of love would entail investigating the chemical changes in the brain during love. A full view of humankind draws on all the sciences—would anyone claim to have complete knowledge of humans, for example, through biology? "A human is nothing but a biological being"—we are, and yet are something much more. The code words "nothing but" indicate a reductionist approach.

Here, the inshore fishery illustrates an issue that must be addressed without reductionism, and efforts to transform coastal societies in sustainable ways must enlist various scientific disciplines and social activities (Salinas-Zavala et al., 2022). Understanding and explanation need to be combined in the joint pursuit of truth by the natural and human sciences, encompassing the social and the profoundly human, i.e., literature, the arts, and ethics. The challenges involved in reversing marine decline are extensive and call for a strong desire for a new relationship with the sea, including values such as beauty and harmony.

Marine knowledge from a processual view

Marine science goes increasingly into detail as new instruments are developed to better resolve observations. The Challenger Expedition (1872–1876) initiated modern oceanography by systematically collecting data worldwide, inspiring new journeys. Today, robotic devices such as Argos buoys drift with currents, capturing ocean data and automatically transferring them to satellites. Other new measurement instruments include autonomous underwater vehicles, remotely operated underwater vehicles, bottom pressure gauges, and sensors on diving animals such as elephant seals (Wunsch, 2015). This range of instruments requires a broad group of experts for their development and handling and for analyzing their results.

Much of our understanding of atmospheric and ocean circulation originates in studies of naturally occurring flows, with Newton's second law serving as a starting point. This law states that mass times acceleration equals the sum of all forces. Newton's equation forms the basis of the momentum equation for large-scale winds and currents (Cushman-Roisin and Beckers, 2011). This equation is highly complex and nonlinear, calling for simplifications in which different time and length scales often guide the work in different applications. The velocity vector is simplified as the sum of a mean, a wave, and a turbulent velocity component, generating many possible solutions. Still, several dynamic features are not resolved or understood, so there is a need to focus on relevant processes. For example, internal mixing requires knowledge of turbulence, which in turn requires detailed knowledge of current flow instabilities. Figure 2 illustrates some natural forces and processes operating in coastal seas such as the Baltic Sea.

Parallel to our developing knowledge of atmospheric and ocean circulation, chemistry and biology have expanded our knowledge of marine waters. Chemistry studies identifying all the elements and their concentrations in seawater have a long tradition. Almost all chemical components are found in the ocean but in substantially different concentrations (Sarmiento and Gruber, 2006). Mapping the chemical elements in seawater is closely related to developing new measuring techniques and extensive sea expeditions. In marine biology, the diversity of organisms has attracted human attention from early history. Recent developments based on improved measuring techniques can detect new species and, for example, processes involving different forms of plankton with significant genetic variations (e.g., Valiela, 1995). There are many different plankton species such as diatoms, dinoflagellates, coccolithophorids, silicoflagellates, and blue–green or other bacteria. Diatoms are among the most diverse and vital phytoplankton groups (Malviya et al., 2016). Processual thinking can go even deeper, concentrating on details and helping solve many scientific and technical problems. A guide to the process-based modeling of lakes and coastal seas (Omstedt, 2015) illustrates the strength of the method for many marine applications, leading to models of different complexities. Environmental models can focus on just a few or a great many studied processes. Reduced or cognitive models concentrate on understanding but do not provide detailed descriptions. At the other extreme, quasi-realistic models create the possibility of simulating and experimenting with real-world systems but fail to produce insight into system functioning (von Storch, 2001).

Human behavior ultimately determines socio–economic processes, simultaneously as there is intense competition in the triangle between policy, media, and science (von Storch, 2012). Coastal seas are subject to many human interests, and the coordination of all these interests can normally only be achieved through an elaborate coastal management process (World Ocean Review, 2017), including a broad range of people with different backgrounds. The psychology of perception regarding marine management also includes how to treat communication processes such as misunderstanding, lack of commitment, non-compliance, and conflicts.

Reckermann et al. (2022) attempted to depict the entire matrix of interrelations of human pressures and the reaction of the sea. They identified several human-induced factors and processes in the Baltic Sea. Some are naturally occurring and modified by human actions (i.e., climate change, coastal processes, hypoxia, acidification, submarine groundwater discharges, marine ecosystems, non-indigenous species, land use, and land cover). Other factors are purely human induced (i.e., agriculture, aquaculture, fisheries, river regulations, offshore wind farms, shipping, chemical contamination, dumped warfare agents, marine litter and microplastics, tourism, or coastal management). The drivers of these factors are, for example, food production, energy production, transport, industry, or economic activities, all of which are essential for coastal sea development. Management processes therefore need to integrate multiple perspectives ranging from, for example, water quality to perception-driven views. De Alencar et al. (2020) considered four domains in a framework for coastal management: environment and ecology, society and culture, economics, and governance and policy. For each domain, they have suggested several indicators to be evaluated and presented according to the EU Water Framework Directive. They have included the UN 2030 Agenda, the Convention on Biological Diversity, and the COP21 Paris Climate Agreement in the governance and policy domain. Adding an increasing number of tasks and specifications to the management of the sea risks making the process overly technical, with a loss of sight of the whole.

Society is divided into many specialties, each of which can be considered almost separate, even if interdisciplinary efforts have been made. There is allure in such an arrangement, in which everything can be predicted, nothing is left to chance, and much can be understood. But with an atomistic or process-oriented view, there is a risk that the knowledge and treatment of nature and humans can become fragmented, engendering an increasing alienation that precludes needed changes.

Marine knowledge from a system view

The 2021 Nobel Prize in Physics focused on the complexity of physical systems, ranging from the microscopic structure of glass to human impact on the climate. The prize was for "groundbreaking contributions to our understanding of complex physical systems." One half of the award was given jointly to Syukuro Manabe and Klaus Hasselmann and the other half to Giorgio Parisi. Manabe showed how an increased carbon dioxide content in the atmosphere gives rise to higher temperatures on the earth's surface, based on the interaction between the radiation balance and the vertical transport of air masses. Hasselmann created a model that linked weather and climate, showing how climate models could be reliable even though the weather is varied and chaotic. These Nobel laureates' contributions yielded an essential earth system understanding by identifying critical processes.

Building a marine system understanding by including essential processes was demonstrated by e. g., Stigebrandt (2001) and Omstedt (2015). The components of a marine system include water volume, position, topography, external influences such as weather, river runoff, inflows of water from surrounding seas, substances such as chemical components or contaminants, and human activities. The state of the marine system can then be calculated from conservation principles involving, for example, water, salt, heat, or chemical or biological components, as well as some central processes such as turbulence, estuarine circulation, and primary production. Exchanges through surrounding sea areas, the atmosphere, land, sediments, and human activities are treated as fluxes executed by boundary processes. Testing the system against observations shows how consistent the modelled processes are with existing knowledge. The water balance is one example that gives us a systemic understanding of how processes such as precipitation and evaporation influence the coastal sea salinity.

Another example is the carbon dioxide–oxygen balance that connects climate change with eutrophication and gives a systemic understanding of how humans affect the sea when they emit nutrients through effluent runoff and greenhouse gases by burning fossil fuels. Here the concepts of detecting changes and attributing their causes are essential. A change can occur for many reasons, and a marine system model can only handle those changes that are included in the system through resolved processes. An example of a process that has only recently been recognized in eutrophication dynamics is phosphorous leaking from sediment during anoxic water conditions (Stigebrandt and Andersson, 2020). Processual and systemic understandings are thus strongly interdependent.

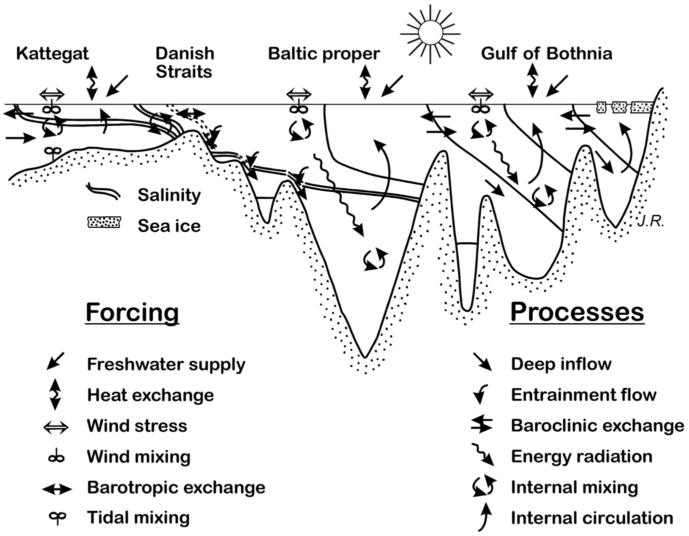

FIGURE 2
Schematic of processes and forcing mechanisms in the Baltic Sea, where the tilted lines illustrate the salinity stratification (redrawn from Winsor et al., 2001; Winsor et al., 2003).

A systemic understanding can involve an increasing number of processes, forming the basis of earth system models with components for the geosphere, physical system, chemical system, biosphere, and human system. These models are similar to climate models but more complex. When studying a complex system such as the coastal seas, not all processes inside the system are known. Some functions are mathematically/numerically resolved, but others are parameterized, meaning simplified or guessed. Identifying the most critical processes entails the risk of neglecting others and causing uncertainties in predictions. The gap in the coastal eutrophication research (Vigouroux and Destouni, 2022), as analyzed from 832 science papers, illustrated that ecological aspects were dominated, with much fewer studies investigating human elements and the coastal filter function. Few studies addressed cross-scale multi-solution management. By comparing different models' outputs, the statistical uncertainty of their results can be calculated. For example, Meier et al. (2018) illustrated significant uncertainties in simulations of eutrophication in the Baltic Sea. However, the study concluded that implementing the Baltic Sea Action Plan with strong nutrient reductions could counteract climate change's (negative) impact. Largely unknown components are human behavior and what pathway humanity will take in the future. Here uncertainties are influenced by drivers such as food and energy production, transport, industry, the economy, culture, education, policy, or war. In marine system models, the human influence may change the system due to fishing or construction and add to the natural flows concentrations of nutrients, carbon, and other substances based on measurements, estimates, and storylines. The human footprints on the coastal sea environment are substantial and complex (Figure 3). Many technical decision-support tools under development include system ideas and indices (e.g., Barzehkar et al., 2021). Simplifications using different indices are also under development, such as the Ocean Health Index (https://ohi-science.org/). The idea is to integrate a large number of management targets into a single index, giving a preliminary overview of the state of the sea and related trends. This approach can also be applied to coastal seas such as the Baltic Sea (Blenckner et al., 2021). However, the complex marine environment cannot be described by just one number or index that replaces a processual or systemic understanding.

How to develop an understanding of the marginal sea system by connecting natural and human sciences has been outlined by Omstedt (2021). Knowledge of processes that foster societal progress or deterioration needs to be considered and, for example, can be closely linked to the success or failure of the United Nations 2030 Agenda for Sustainable Development. Agenda 2030 goals are integrated and inseparable and balance the three dimensions of sustainable development: economic, social, and environmental. These goals include no poverty or hunger, good health, quality education, gender equality, clean water, affordable energy, and peace. Addressing these societal challenges is essential for reversing the decline in the marine environment (e.g., Omstedt, 2021). Agenda 2030 is now a top political priority, and the progress made on its various goals can be seen at Our World in Data (https://ourworldindata.org/). At the same time, the United Nations Development Programme (UNDP) analyzes human development partly by using the Human Development Index (e.g., Amartya Sen, 2020) as a

FIGURE 3
Many different human activities damage the seas. What do our human footprints or impacts look like? Looking at the photo through the lens of art, one imagines that the question also addresses multiple human stresses on the seas? (Photo courtesy of Hillevi Nagel).

measure of action related to health, education, and income. Many human activities now affect the marine environment, interacting with other factors often in unknown ways (e.g., Reckermann et al., 2022). A careful analysis of the dominant processes in nature and society is needed before improved system insight can be gained.

Discussion

Humans and the coastal seas are closely connected, often imposing multiple stresses on the marine environment. Humans have not yet learned to work with the marine environment for the benefit of all—cooperation that would offer significant gains for both the sea and humans. The need for a change in behavior toward the ocean and its coastal seas is why the United Nations has launched the UN Decade of Ocean Science for Sustainable Development (2021–2030) e.g., Claudet at al., (2020). The vision is to take transformative human action to safeguard "the ocean we need for the future we want." Today society is developing interdisciplinary and transdisciplinary programs to overcome fragmentation within science and technology. Our understanding of the nature of reality is illustrated in Figure 4, which, unlike Figure 1, incorporates the passage of time. Perception evolves when new processes or systems are studied from new perspectives. For example, our understanding has evolved from a geocentric to heliocentric worldview, through Newton's understanding of nature, and later to the insights of relativity and quantum mechanics; or from the Linnaean classification of species to Darwin's studies of evolution, and to today's genomics studies; or from pre-industrial societies, through the industrial revolution, and now to post-industrial societies in which services generate more wealth than does manufacturing.

In the future, we may expect further aspects to be considered in such highly complex social and natural environments as coastal and island systems. A processual understanding leads to an atomistic view, and a scientific approach that only goes into more and more detail will not help. A systemic understanding involves holistic thinking and universal values and is necessary for creating harmony between society and the seas. Here we understand harmony, similar to a successful transdisciplinarity program, as a metaphor for an orchestra in which the various musicians play synchrony. Harmony between humans and the sea includes an agreement to play together in the sense of peace. This aspect leads to more holistic/universal thinking that will help to improve the marine environment when going into scientific or technical problems. As such, it should not be operationalized by finding out a number of measures. The universal claims are here also central, e.g., formulated by the United Nations in Agenda 2030, in contrast to particular national claims for reversing the decline in the marine environment. The atomistic and holistic, particular and universal, and processual and systemic understandings should not be treated as dichotomies or as contradictory perspectives; instead, our understanding of reality changes when these complementary perspectives meet. The number of processes has and will increase even more. However, system understanding does not need to include all but only essential ones

Expecting society to work together requires a shift from fragmentation to integration. The division between humans and nature can be illustrated by urbanization. The United Nations estimates that 55% of the world's population resided in urban areas in 2018, and that by 2050, 68% may well live in urban areas. By way of comparison, only 30% of the world's population was urban in 1950, see extensive information about global population dynamics in Our World in Data (https://ourworldindata.org/). Living conditions have drastically changed from rural farming or fishing to modern city life. Crucial values associated with climate and environmental changes are at stake, and environmentally friendly progress cannot be reduced to a battlefield of ideas and interests. Different perspectives need to meet; at the same time, their proponents must improve their understanding of human

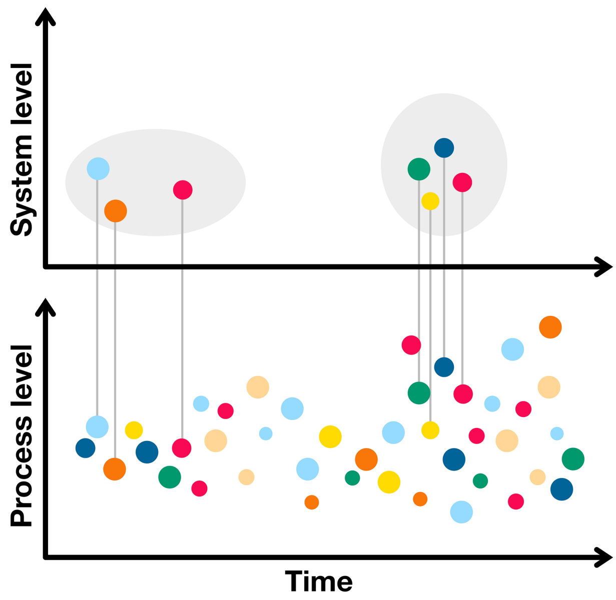

FIGURE 4
Sketch of how processes and systems change over time. The circles indicate various processes, some of which form parts of systems.

behavior and of human perceptions of the sea (e.g., Omstedt, 2020; Pendletona et al., 2020; Omstedt, 2021; World Ocean Review, 2021). A successful Decade of Ocean Science for Sustainable Development calls for practical and wise leadership, clear vision, societal involvement, information sharing, admitting the ocean's—and human—vulnerability, and storytelling (Omstedt and Gustavsson, 2022). An example of new information sharing is the depiction of different "voices" from long-term ecological research, telling us how to establish effective dialogue between measurements and society (Pugnetti, 2020).

Something else is also needed to prevent a decline in the highly complex social and natural marine environment. Here we suggest that the way forward is by promoting human values such as beauty, and harmony between humans and the sea, values that go beyond sustainability. Devising methods for promoting positive human values touching on the whole will better serve the need to improve the marine environment than will progress achieved solely through science and technology. We argue that it is not enough to develop new scientific results; we must also reject the idea that facts and values are not connected as they concern coastal seas. Beauty has an extraordinary quality that stimulates curiosity, wonder, and awe, encourages acts of bold exploration, and is a part of the economic value of, e.g., beaches for recreation (e.g., surfing Lazarow et al., 2009). Franke et al. (2020) associated biodiversity as another essential aspect of beauty. Sustainability, referring merely to resources being used so that they are never exhausted, is not enough, as this could be done in many ways without considering what is good for humans. Harmony adds something more than sustainability, promoting feelings of belonging, responsibility, and peace.

Many possible examples within marine planning and management can promote progress in the human sea relation. When looking at different attempts, the marine protected area could foster harmony in the human–sea relationship (e.g., https://en.unesco.org/news/harmony-sea-story-marine-protected-area). Modern offshore wind turbines are becoming more extensive, and wind energy can become an essential alternative to fossil fuels (World Ocean Review, 2021). Today, large offshore areas are planned for wind energy, promoting more sustainable energy production. However, wind farm construction can conflict with other marine interests and may increase alienation from the sea. Such offshore installations should not be constructed without integrating multiple interests and considering designs that incorporate beauty and harmony, biodiversity, recreation, and sustainable fishery. Marine wind farm design is only one instance where progress in the human–coastal sea relationship could be promoted; other examples are construction in coastal cities, fishing regulations, harbor management, pollution restrictions, and culture. Many conflicts can easily cause the fragmentation rather than improvement of the marine environment, and new efforts to change our mindsets are needed. All planning of human initiatives should start with the question of how we can create a vision that promotes beauty and harmony for all those living in coastal areas. The answers will rely on actions that involve everyone living in or near coastal seas. Also, these initiatives must prioritize a healthy environment and encourage new solutions having no negative impacts on the sea.

Summary and conclusions

Due to human activities on land, in the atmosphere, and at sea, many factors exert tremendous pressure on the marine system. Urbanization is intense, and today over half of the global population is living in and around cities. Traditional lifestyles such as farming, and fishing are declining in favor of urban lifestyles with the associated risk of increased marine alienation. From being seen as an infinite resource free to explore and exploit, the ocean is now perceived as endangered, without adequate safeguards to protect the marine environment. International initiatives are being taken through the United Nations Ocean Decade (2021–2030) to change human behavior toward the ocean and its coastal seas. This paper addresses human perceptions of complex environments by examining different ways of investigating the nature of reality. The starting point is the relationship between atomism and holism. Here philosophy and physics have a long tradition of describing the fundamental elements of life in terms of how everything is connected. The idea is that one needs to understand the essential components before understanding the whole. Another claim is that the whole is more significant than its parts. Atomism and holism have been treated as antithetical, but "to see a world in a grain of sand," as stated by Blake, opens a relationship between them. Relationships between essential components and the whole are studied in many scientific disciplines, including the marine sciences.

The distinction between particular and universal claims is added to that between atomistic and holistic views and broadened to encompass context. Here universal means something applicable to all, whereas the particular applies only to a limited group. We can compare the atomistic and holistic with the universal and the particular and come to a clearer picture of the conditions for the ocean. In marine science, processual and systemic insights represent a similar dichotomy between details and the whole. In general, when solving marine problems, the discussions focus on processes in an atomistic/particularistic way. An atomistic/particularistic perspective can lead to fragmentation, while a sound systemic view considers the whole and is essential for building harmony. Therefore, noteworthy is opening a dialog between scientists and stakeholders about systemic understanding with holistic thinking and universal values. The relationship between processual and systemic understandings is obvious in coastal sea models, where changes only can be calculated if relevant constituent processes are included.

This discussion leads to the following summary conclusions, highlighting the marine perspective:

- With an atomistic view, there is a risk that knowledge and the treatment of nature and humans may become fragmented into many separate and conflicting compartments. A holistic approach opens up the whole but at the risk of oversimplification.
- The distinction between particular and universal claims is essential here. Notably, universal human values formulated in the UN Agenda 2030 are critical for reversing the decline in the marine environment.
- Adding an increasing number of processes to sea management initiatives could increase alienation from the sea and cause us to lose sight of the whole.
- Atomistic and holistic, particular and universal, processual and systemic understandings should not be regarded as dichotomous or contradictory; instead, when these complementary perspectives meet, they can change our understanding of reality including the marine environment.

Data availability statement

The original contributions presented in the study are included in the article. Further inquiries can be directed to the corresponding author.

Author contributions

AO and BG conceived the research. AO wrote the first draft, and BG contributed substantially to revisions. All authors read and approved the final manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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