

Beyond Surfonomics: Towards a Conceptual Model of Sustainable Development, Ecosystem Services and Positional Analysis in the Valuation of Waves

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Abstract

This paper develops a transdisciplinary conceptual framework for understanding the value of coastal wave resources by integrating surfonomics, ecosystem services, and sustainable development. While surfonomics has typically focused on the economic value of surfing through market and non-market valuation techniques, such approaches provide only a partial account of the complex ecological, social, and cultural values embedded within surfing environments. Addressing this limitation, the paper situates surfonomics within a broader theoretical context that draws on ecosystem services, natural capital, and positional analysis.

The paper draws on the concept of the surf system boundary to capture the dynamic and interconnected nature of coastal environments where surfing takes place. It then develops a conceptual model that positions sustainable development as an overarching epistemological lens, linking ecological modernisation and reflexive modernity within a risk society framework. Through this lens, ecosystem services and natural capital are reinterpreted as part of a wider, pluralistic valuation process shaped by competing stakeholder perspectives.

The paper contributes to coastal management by offering an interdisciplinary framework that moves beyond narrow economic valuation towards a more integrated understanding of coastal resources. It highlights the importance of recognising multiple forms of capital and the interactions between ecological and social systems, providing a foundation for more inclusive and reflexive governance approaches to the management of coastal and marine environments.

Keywords

Valuation, sustainable development, surfonomics, natural capital, reflexivity, surfing

1. Introduction

This paper uses the activity of ocean surfing to explore and expand conceptual frameworks relating to the fields of surfnomics, sustainable development and ecosystem service valuation. In doing so, the paper proposes a conceptual framework that situates surfnomics within broader debates surrounding sustainable development, ecosystem services and environmental governance. This also has implications for how governance systems interpret, prioritise and act on different forms of value within coastal and marine decision making contexts. The paper contributes to emerging debates surrounding how environmental valuation frameworks can better account for the complex ecological, social and cultural values embedded within coastal environments. By integrating insights from positional analysis and risk society theory, particularly a reflexive modernity, the paper aims to move beyond narrow economic valuation approaches. It offers a more comprehensive perspective on the value of the surfing environment. The paper argues that there is a need to reconceptualise the narrow economic accounting processes that currently present an incomplete picture of the value of surfing. To address this limitation, the paper critically explores the role of natural capital and ecosystem service valuation as providing a stronger foundation for understanding the value of the surfing resource.

The paper proceeds in the following manner. First, the field of surfnomics is introduced and discussed within the broader context of the activity of ocean surfing, where the spatial environment in which surfing occurs is established. Particular attention is given to the complex interactions that shape areas where surfing takes place, highlighting the idea of surf system boundaries. Sustainable development is then introduced and the conceptual framework associated with it is explored. The relationship between sustainable development and reflexive modernity is discussed in order to establish a connection between these ideas. Building on this discussion, a broader conceptual model is developed that brings together a number of relevant concepts in order to contextualise the subsequent discussion of natural capital and ecosystem services.

The paper then revisits the central tenets of ecosystem service valuation and presents a model that establishes a relationship between sustainable development, natural capital and ecosystem services. This model emphasises the indivisibility of a number of capitals that together create a flow of ecosystem services that benefit human societies.

2. Surfanomics

The activity of surfing engages millions of people around the world. Whilst estimates vary, some figures place the number of surfers globally at over 35 million (O'Brien and Eddie, 2013; International Surfing Association, 2015). When those who engage with surfing culture through film, imagery, and lifestyle-related products are considered, this figure increases significantly, reflecting the broader cultural identity and symbolic meanings associated with surfing communities (Martins et al., 2023). This engagement has created a multibillion dollar industry. The Surfing Global Market Trajectory and Analysis report estimates that the global surfing market, currently valued at approximately US\$2.7 billion, is projected to increase to US\$3.1 billion by 2026 (Global Industry Analysts, 2022). There is therefore a global economic value associated with waves. However, there is also a more direct value associated with specific surfing locations. These benefits are derived from engagement with particular wave resources, including factors such as wave quality, consistency, bathymetry, coastal morphology and local environmental conditions. The way in which this space is defined is therefore important for identifying the components that contribute to the value of a wave in any given location. This spatial dimension forms an important part of surfonomic calculations.

The term surfonomics itself has been employed broadly over the last decade and overlaps with other areas such as coastal economics, sustainable tourism, environmental economics, sports economics, tourism economics, ecotourism, coastal management and conservation economics. Within the surfing industry, the term is often used to present statistics relating to the global surfing population, participation by gender, and income levels (SIMA, 2024). These statistics are also used to demonstrate and test markets for surf related products and activities.

Not for profit organisations such as the Surfrider Foundation, Surfers Against Sewage and the Save the Waves Coalition have also utilised economic valuation to demonstrate the importance of surfing to particular locations, particularly in policy and planning debates. Surfanomics therefore forms a central component of the Save the Waves Coalition's World

Surfing Reserve designation programme, which aims to document surfing's financial contribution to local and regional economies in order to support decision-making relating to coastal protection (Save the Waves Coalition, 2024). A growing body of research has also begun to explore the governance and conservation implications of surf breaks, including the role of surf reserves and legal protection mechanisms for surfing environments (Arroyo et al., 2019; Orchard et al., 2023; Scheske et al., 2019; Short and Farmer 2012; Touron-Gardic & Failler, 2022). Recent work has also begun to position wave reserves within broader debates surrounding marine conservation and sustainable ocean governance (Touron-Gardic & Failler, 2022)

Within the academic literature it is recognised that surfonomics encompasses 'a vast array of methodologies and techniques designed to capture the economic influence and significance of the sport of surfing' (Scorse and Hodges, 2017:137). These authors outline several methodological approaches within surfonomics. The most common involves measuring direct expenditure in a particular location. This may include spending associated with hotels, restaurants, surf lessons, international competitions, surf equipment, merchandise, and other related activities.

Surfing also produces significant non-market economic value. This can broadly be divided into three areas. First, non-use value, which is non-consumptive or indirect and often measured through contingent valuation methods. Second, consumer surplus, commonly estimated through travel-cost models. Third, capitalised real estate value, which may be assessed through hedonic pricing approaches. Leon et al. (2023) provide a useful overview of both market and non-market valuation studies that have been conducted in surfing locations, including areas designated as World Surfing Reserves.

However, non-market valuation techniques can present challenges when attempting to establish realistic values. Contingent valuation methods based on willingness to pay, for example, may raise concerns regarding ability to pay or the appropriate group to survey (Brown, 2017). Furthermore, valuation outcomes may be influenced by ideological differences regarding environmental priorities. As Dietz et al. (2005:346) observe, 'groups might contest the evidence surrounding the impacts of climate change on endangered species,

or they might differ in the values they assign to the perpetuation of rare species, or both' (2005:346).

These limitations suggest that there is a need to expand the way surfing resources are understood, not only practically and technically, but also at the epistemological level. What is argued here is that an important first step in achieving this is recognising that many valuation techniques used within surfonomics draw heavily on ecosystem service valuation methodologies, particularly in relation to non-market valuation approaches. Whilst Manero and Mach (2023) have begun to explore this relationship, movement towards a more sophisticated understanding of the value of a wave resource within a particular geographical location remains limited.

Recognising this limitation highlights the need for a deeper examination of the epistemological assumptions that underpin both surfonomics and ecosystem service valuation. In order to address this, a broader theoretical approach is required. The following section therefore explores the spatial context within which surfing occurs before moving towards the development of a conceptual framework capable of integrating the key themes of this paper.

2.1 The Surfing Space

As discussed previously, the surfing space and the location of the valuation activity are central components of the surfonomics process. The term surfing ecosystem has emerged as a popular way of describing the interacting variables that constitute the surfing space, surfing ecosystems, have been defined as 'the spaces and complex interactions between the multiple living and non-living components of ocean and coastal environments where surfing takes place. These may include elements such as waves, reefs, currents, sediment, flora and fauna, as well as surfers themselves and other stakeholders who utilise these spaces' (Manero and Mach, 2023:1611).

This representation of the surf space resonates strongly with earlier descriptions that refer to the surf system boundary (SSB). Martin and O'Brien (2017) introduce the concept of surf system boundaries to highlight the complex and interrelated areas that exist within and around a surf break. They recognise that a surf system boundary 'is more than the beach and

sea; it encompasses numerous stakeholder interests and factors related to the whole surf system as a sustainable and dynamic model' (Martin and O'Brien, 2017:23). These authors outline both the physical boundaries of the surf environment and the range of stakeholders connected to the resource, providing a useful foundation for understanding the broader dynamics of the surf system boundary.

Importantly, and as identified previously, Martin and O'Brien underline that two paradigms coexist when exploring surfing sites. These perspectives involve the global value of the surfing industry alongside the value attributed to specific surfing locations by individuals and local communities (Martin and O'Brien, 2017:35). Moving forward, this paper adopts the surf system boundary definition of the surfing space and applies it to the subsequent discussion of World Surfing Reserves. There are two principal reasons for adopting this approach. First, the concept of a surf system boundary more accurately reflects the interactive and dynamic nature of the surfing space. Second, as this paper engages directly with ecosystem services, avoiding the term surfing ecosystem helps maintain conceptual clarity between the ecological environment and the analytical frameworks used to understand it. With surfonomics and the surfing space established, the following section outlines the theoretical and conceptual framework that expands upon and connects surfonomics, sustainable development, natural capital and ecosystem services. Sustainable development provides the starting point for this discussion.

3. Sustainable Development

With the establishment of the Sustainable Development Goals in 2015, preceded by the Millennium Development Goals, sustainable development has emerged as a central and dominant narrative in contemporary society. Today, sustainable development continues to feature prominently on social, economic, environmental and political agendas, with significant effort, finance and institutional capacity directed toward the implementation of the 17 SDGs across sectors.

Despite this prominence and concerns about progress towards the SDGs, sustainable development remains a contested and often ambiguous concept (Borne, 2010). The frequently

cited Brundtland definition ‘development that meets the needs of the present without compromising the ability of future generations to meet their own needs’ (WCED, 1987:10) provides an important starting point. However, the concept inherently involves trade-offs between environmental protection, social welfare and economic development. As a result, sustainable development remains fluid and negotiated, requiring ongoing critical reflection.

The emergence of sustainable development has also had important implications for the evolution of conventional economic thinking and for how relationships between society, economy and the natural environment are understood (Beckerman, 2015; Daly, 2007; Goldin and Winters, 1995; Pearce, 1988; Hess, 2016). Concepts such as the circular economy and doughnut economics (Raworth, 2018; Turner and Wills, 2022) have gained prominence in both academic and policy debates as attempts to reconnect economic systems with ecological limits and social foundations. While these approaches represent important developments, they also highlight the need to examine the underlying assumptions that continue to shape economic approaches to sustainable development. One perspective that offers insight into these assumptions is the notion of positional analysis (Söderbaum, 1982; Brown et al., 2017). In particular, the work of Brown et al. (2017) provides an interesting conceptual bridge between positional analysis, sustainable development and the valuation of natural capital and ecosystem services.

4. Positional Analysis

Positional analysis, introduced by Peter Söderbaum, provides a perspective for addressing complex decision-making problems in the context of sustainable development. It challenges the conventional approach of economic cost benefit analysis by emphasising pluralism, multidimensionality and ethical considerations. Söderbaum is highly critical of purely economic cost benefit analysis techniques because they rely on monetary valuation as a single metric, often overlooking the multiple values and trade-offs embedded within sustainable development.

Essentially, positional analysis recognises the pluralistic nature of values, emphasising that individuals and stakeholders hold diverse and sometimes conflicting perspectives that are

central to understanding decisions relating to sustainability. This also highlights the importance of recognising stakeholders not only as holders of different values, but as active participants in shaping decision making processes and governance outcome. Positional analysis therefore seeks to move beyond purely monetary metrics and instead embraces social, environmental and ethical dimensions, reflecting the multidimensional character of sustainable development. In doing so, positional analysis emphasises the importance of incorporating the perspectives of a broad range of stakeholders in order to ensure inclusiveness and relevance within decision-making processes. This emphasis on stakeholder perspectives resonates with wider ecosystem services research that highlights the importance of participatory approaches and stakeholder engagement when evaluating environmental benefits (Burdon et al., 2019; Hölting et al., 2020).

A further feature of positional analysis is its emphasis on clarifying the context, alternatives and possible consequences associated with particular decisions rather than prescribing a single ‘optimal’ solution. The application of this perspective to sustainable development has been consolidated in the work of Brown et al. (2017), who explicitly connect positional analysis with debates surrounding sustainable development, natural capital and ecosystem service valuation. Brown et al. (2017) notes that ‘sustainability and sustainable development are underpinned by plural and often conflicting values and can be interpreted in many different ways, leading down quite different societal pathways’ (2017:130). Söderbaum further argues that even within contemporary sustainability discourses, including those relating to the green economy, economic analysis often remains rooted in neoclassical approaches that prioritise full cost pricing and monetary calculations of net present value through cost benefit analysis.

Within this context Söderbaum highlights the continued relevance of alternative analytical approaches such as positional analysis (Söderbaum, 2017d). Importantly, these discussions also engage directly with debates surrounding ecosystem services and natural capital valuation, particularly in relation to frameworks such as The Economics of Ecosystems and Biodiversity (TEEB). While Söderbaum acknowledges that the TEEB framework has helped stimulate constructive dialogue around the value of nature, he also describes it as reflecting a degree of cognitive and ideological inertia, noting that references are frequently made to early

studies that emphasise the concept of total economic value expressed in monetary terms (Söderbaum, 2017c). From this perspective, reducing ecological services to a monetary equivalent risks oversimplifying the broader social and ecological values associated with sustainable development. Söderbaum therefore concludes that although recognising ecosystem services is essential, sustainable development ultimately concerns broader forms of non-monetary progress (Söderbaum, 2017c:26).

While the authors of this paper agree with and draw on this observation, such critiques can sometimes overlook the complexity of ecosystem service valuation methods and the assumptions embedded within them. There is therefore a need to revisit the underlying propositions of natural capital valuation more carefully. In doing so it becomes possible to recognise that positional analysis and natural capital valuation may share certain underlying goals. For example, Söderbaum suggests that rather than attempting to ‘solve’ a problem in a final or definitive manner, the purpose of positional analysis is to illuminate a decision situation for politicians, stakeholders and other actors concerned with the issue (Söderbaum, 2017d:31). In the following discussion, the extent to which natural capital valuation shares this underlying objective will be explored.

We begin by acknowledging that positional analysis argues that what is required is an economic perspective which seeks to move away from conventional economic accounting and cost benefit analysis. There are two pertinent aspects here that inform the development of a more sophisticated conceptual and theoretical approach. Firstly, positional analysis recognises that sustainable solutions are intrinsically related to the functioning of a reflexive and deliberative democracy, and therefore socially and ecologically relevant economics must be able to account not only for complexity and uncertainty but also to engage and communicate with society and policymakers. Secondly, positional analysis identifies ecosystem services and natural capital accounting as important, but ultimately limited mechanisms for achieving sustainable development. The following discussion seeks to address these concerns and build a more robust conceptual framework by drawing connections between sustainable development and a risk society.

5. Sustainable Development in a Risk Society

Recognition of the value of sociological perspectives on risk as providing insight into ecosystem service narratives is beginning to emerge (Peters, 2020). Moreover, it has previously been established that viewing sustainable development through the lens of a risk society enables a critical reflection on the broader role of the concept within contemporary society (Beck, 1992; Borne, 2010). The proposition that society is increasingly organised around the distribution of risks and ‘bads’, rather than the modernist focus on the distribution of goods, forms the basis of Ulrich Beck’s risk society thesis. Within this interpretation of modernity emerges the notion of reflexive modernity, which challenges some of the central assumptions of the modernist project, including notions of progress, rationality and the dominance of scientific expertise. Importantly, reflexivity within this context operates at multiple scales. At the macro level it can be observed in the actions of international organisations and global governance structures, while at the micro level it is reflected in the practices of communities and individuals (Borne 2026). Reflexivity is therefore not only a conscious response to global risks such as climate change, but also encompasses the unintended and often unconscious adaptations that emerge within social structures as societies respond to environmental risk. Reflexivity can also be understood as shaping more adaptive, participatory and context responsive forms of governance, where decision making evolves in response to both environmental change and social learning

It is argued here that sustainable development and reflexive modernity display significant synergies that together establish a discursive relationship. These synergies emerge in several ways. Both expose the relationship between humanity and the environment; both call into question established notions of progress, science and rationality; both blur the boundaries between the global and the local; and both raise concerns regarding intergenerational equity and the incompatibility of geological and political timescales. This paper therefore builds on the proposition that sustainable development may be understood as part of the broader emergence of reflexive modernity (Beck, 1992; Borne, 2026). In doing so it also extends the application of this perspective within surfing related research and governance (Borne, 2018; Borne, 2023; Borne, 2024), while simultaneously bringing these insights into conversation with the fields of ecosystem service valuation and surfonomics. The following section therefore establishes the relationship between sustainable development, ecosystem services

and surfnomics. At this point natural capital and ecosystem services are introduced in order to examine how these concepts interact with both sustainable development and the valuation of surfing environments.

6. Natural Capital and Ecosystem Services

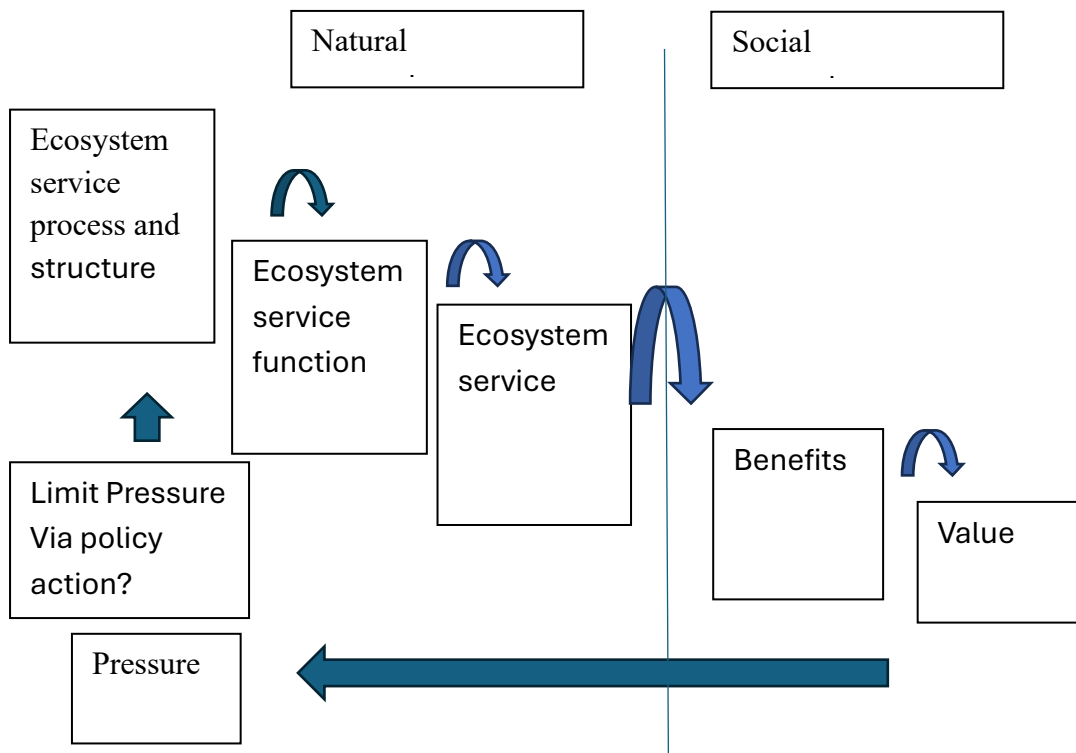
Natural capital is commonly defined as the stock of renewable and non-renewable natural assets that generate a flow of benefits to society (Costanza & Daly, 1992; Hou et al., 2019). The notion of natural capital has also informed international policy debates surrounding the transition towards a green economy and the integration of ecosystem services into national accounting frameworks (UNEP, 2011). More recently, the application of natural capital and ecosystem services approaches has expanded into areas such as land valuation, environmental governance and professional practice, reflecting the growing recognition that ecological assets underpin long-term economic and social wellbeing (Borne, 2024).

Similar to the definition provided above, the UK Environment and Audit Committee describes natural capital as the stock of natural assets, including ecosystems, that yield a flow of benefits to people through ecosystem services. The concept emphasises that these natural systems function as forms of capital, comparable to produced capital such as infrastructure or buildings, and human capital such as knowledge and skills.

At its most fundamental level, ecosystem services represent the benefits that humans derive from the natural environment. Ecosystem services research has expanded rapidly over the last two decades (Pan and Vira 2019), particularly in marine and coastal contexts where the links between ecosystem functioning and human wellbeing are increasingly recognised (Calapez et al., 2023; Liqueste et al., 2013; Wood et al., 2018; Martínez-López et al., 2019; Casal & McCarthy, 2023). The Millennium Ecosystem Assessment (MEA, 2005) identifies four broad categories of ecosystem services: provisioning services such as food and water; regulating services such as climate regulation and water purification; cultural services such as recreational and aesthetic benefits; and supporting services such as nutrient cycling and soil formation. The relationship between ecosystem processes and the benefits derived by society is often illustrated through the ecosystem services cascade model. This model establishes a

relationship between the biophysical characteristics of ecosystems and the social and economic benefits that ultimately flow from them.

Figure 1: Cascade Model



(Adapted from Zhang et al., 2022)

In this model, the first component concerns the natural ecosystem. Within this domain there is a progression from ecosystem processes and structures to ecosystem functions and ultimately to ecosystem services. The second component relates to the socio-economic system, where ecosystem services generate benefits and value for human societies. The third component introduces a feedback mechanism linking these benefits to policy action, recognising the finite nature of ecosystem structures and the pressures placed upon them. Explicit recognition of the connection between surfonomics methodologies and ecosystem services has only recently begun to emerge within the surfing literature (Manero and Mach, 2023; Manero et al., 2024). However, there are clear parallels between the methods used to assign value to surfing locations and those employed in ecosystem services valuation. This is particularly

evident in non-market valuation techniques, including contingent valuation and revealed preference approaches. Similar approaches have been applied in coastal recreation studies more broadly, including the valuation of fishing harbours and other coastal leisure environments (Ceccacci et al., 2024).

Manero et al. (2024), conduct a national assessment of the economic and wellbeing impacts of recreational surfing in Australia. Situated within the broader context of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030), the study utilises the SEEA EA framework and recognises that although surfing is widely acknowledged as a cultural ecosystem service, both the monetary and social values associated with recreational surfing remain poorly documented, even in premier surfing locations. Cultural ecosystem services have become an important area of research within ecosystem service studies, particularly in relation to coastal and marine environments where recreation, identity and cultural values are closely intertwined (Quevedo & Kohsaka, 2024).

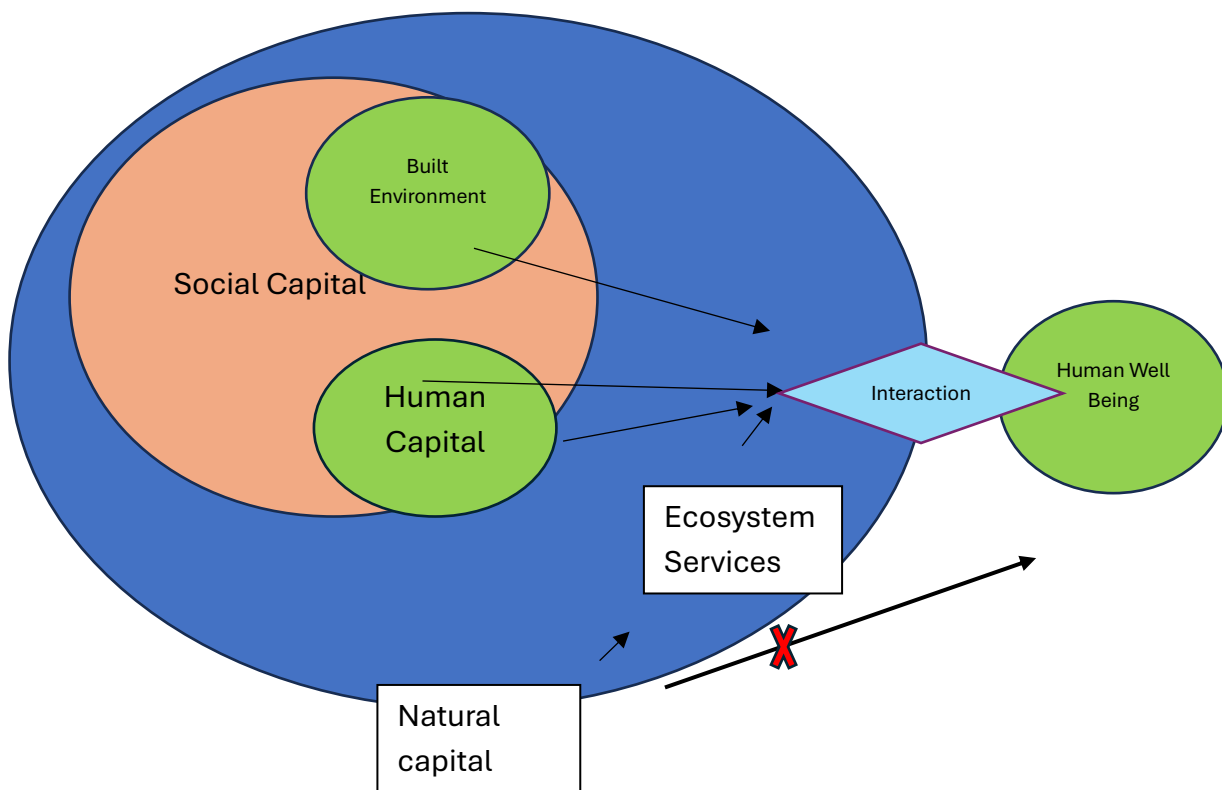
Similarly, Manero and Mach (2023) explore the relationship between surfing and the wider ecosystem services framework, highlighting connections not only to cultural ecosystem services but also to provisioning, regulating and supporting services. In doing so they identify five forms of capital associated with ecosystem services: natural, human, socio-cultural, financial and built capital. However, these authors also recognise that such classifications have been criticised for failing to fully capture the complexity and dynamism of interactions between human societies and natural systems. This observation reflects a broader theme within the ecosystem services literature and reinforces the need for a more sophisticated theoretical and conceptual framework.

Within the context established earlier in relation to sustainable development and positional analysis, it becomes necessary to examine more closely some of the underlying assumptions that shape ecosystem services valuation and to consider the implications of these assumptions for surfonomics. While the cascade model presented above provides a useful framework for identifying relationships between ecological processes and socio-economic outcomes, ecosystem service valuation methods remain diverse and contested (Li et al., 2023). In

particular, the assumption that ecosystem services can be isolated and quantified independently of the systems from which they emerge presents challenges. This is especially clear when assessing the full value of a surfing resource

At this point it becomes necessary to return to the broader theoretical framework developed in the preceding sections, which integrates perspectives from sustainable development, positional analysis and risk society theory in order to explore the relationship between surfonomics, ecosystem services and their value to society. One way of doing so is by revisiting the concept of capital within ecosystem services frameworks. Following Costanza et al. (2017), ecosystem services can be understood as embedded within the broader sphere of natural capital, which interacts with other forms of capital including social, human and built capital. These interactions collectively contribute to human wellbeing and shape how individuals and communities experience environmental benefits (Ward et al., 2023).

Figure 2: Capitals for human well being



(Source: Costanza et al., 2017)

As illustrated in this model, interactions between natural, social, human and built capital are required in order to generate human wellbeing. Importantly, these capitals do not operate independently. Instead, they interact dynamically, meaning that the contribution of any single capital cannot be understood in isolation.

This insight has important implications for ecosystem services valuation. If ecosystem services arise from the interaction of multiple forms of capital, then attempts to isolate and monetise individual services may fail to capture the broader dynamics through which value is produced. Similar critiques have been raised in debates surrounding critical natural capital, which emphasise ecological resilience and the limits of substitutability between natural and economic capital (Brand, 2009). Costanza et al. (2017) therefore emphasise that understanding ecosystem services requires a transdisciplinary approach capable of engaging with the complexity of interactions between ecological and social systems.

Furthermore, this conceptualisation moves away from the linear cascade model discussed earlier. As Costanza et al. (2017) note, linear models struggle to capture the complex connections and feedback mechanisms that exist between ecological processes and social systems. This recognition highlights a broader challenge for ecosystem services valuation, which is that no single valuation technique can fully capture the complexity of ecosystem interactions. Therefore, there ‘...is not one right way to assess and value ecosystem services. There is however a wrong way, that is, not to do it at all’ (Costanza et al., 2017:3). From the perspective of surfonomics and the surf system boundary, this suggests that new approaches are required that integrate the multiple forms of capital that contribute to the value of surfing environments.

Echoing the concerns raised by Söderbaum and Costanza, Everard (2022) cautions against attempts to assign absolute values to natural assets. Instead he suggests that valuation exercises should focus on marginal changes relative to specific baseline conditions. Everard also emphasises the geographical and policy specificity of valuation processes, noting that ‘...valuation studies therefore have to be regarded as relevant to a fixed physical location and time’ (Everard 2022:125).

As with Söderbaum and Costanza, Everard also points out that pluralistic values, depending on culture, religion, location and more, are innately present within a valuation of nature. Rees et al. (2022) reinforce this point indicating that there is ... ‘a complex relationship between the condition of an eco-system and the provision of ecosystem.... it is challenging to link to economic outcomes’ (2022:1100), Rees points to the need for an increased emphasis on social cultural, ethical, and psychological variables. At this stage it is useful to pause and recognise two key observations that emerge from the preceding discussion. First, the analysis strengthens the conceptual connection between surfnomics and ecosystem services valuation. Second, it highlights the need to examine the epistemological assumptions that underpin valuation processes. In doing so, the discussion draws attention to the broader intellectual context within which ecosystem services valuation operates.

As Everard (2022) recognises, ‘valuation of ecosystem services is currently polarised between the neoclassical economic perspective and recognition of a far wider suite of non – marketed yet still important services’ (Everard 2022:114). This tension provides an entry point for the development of the conceptual framework presented in the following section, which seeks to position ecosystem services and natural capital within a broader understanding of sustainable development.

7. The Theoretical Framework

The preceding discussion highlights the need for a conceptual framework capable of integrating the key themes explored in this paper. In particular, it demonstrates the need to position surfnomics and ecosystem service valuation within a broader understanding of sustainable development and the epistemological debates that surround environmental valuation. Figure 1 presents the theoretical framework that informs the subsequent discussion.

Figure 3: Theoretical Framework

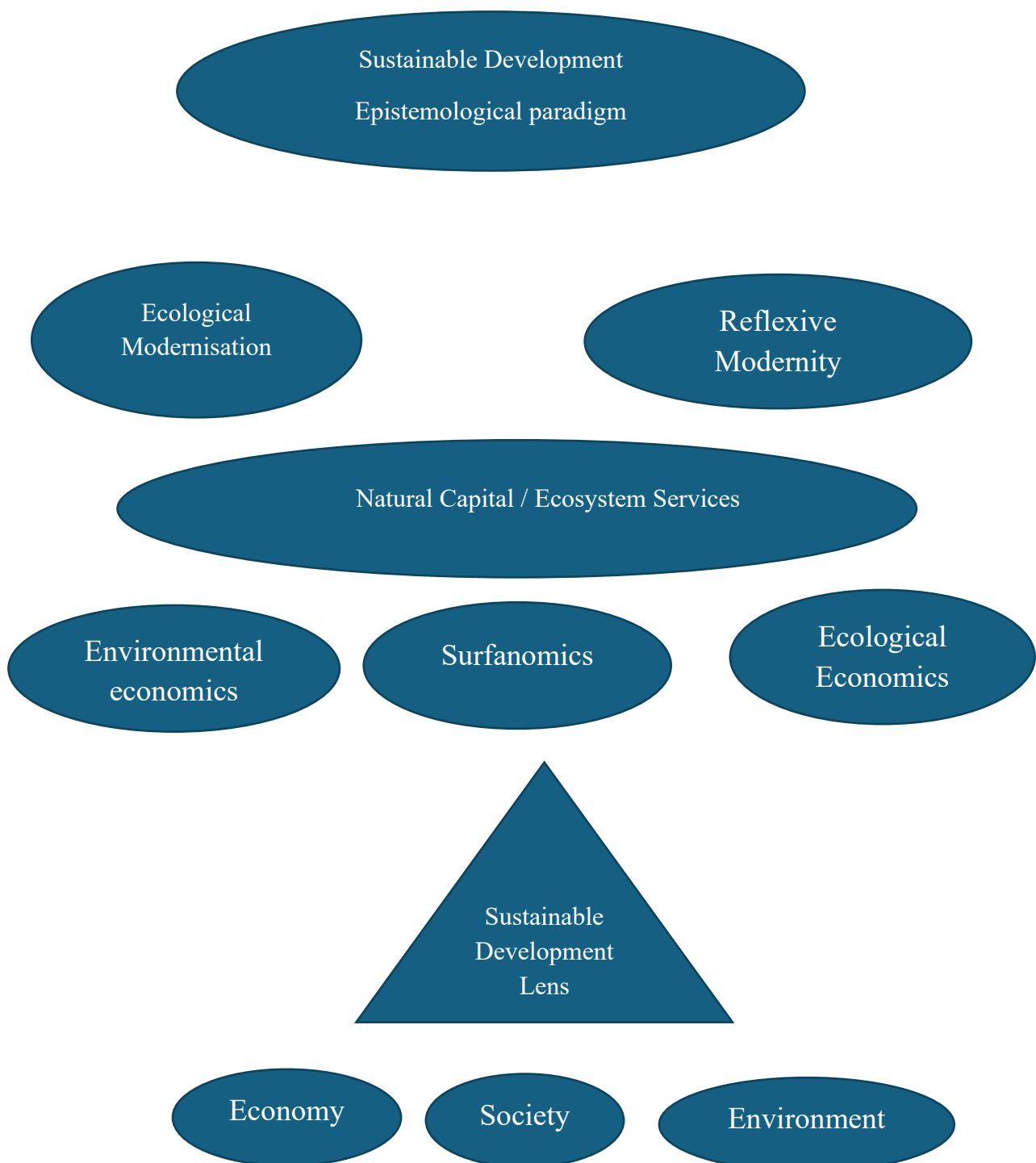


Figure 1 illustrates the conceptual structure that underpins the approach adopted in this paper. At the centre of the framework sits sustainable development, which functions as a lens through which relationships between society, economy and environment can be understood. Using sustainable development in this way recognises the concept not only as a policy goal but also as an epistemological framework through which environmental, social and economic relationships may be interpreted.

Within this framework, sustainable development exists along a spectrum that reflects the tension between ecological modernisation and reflexive modernity. At one end of this spectrum ecological modernisation emphasises technocratic solutions to environmental challenges (Huber, 1995; Hajer, 1995). Within this perspective environmental problems are often framed as challenges that can be addressed through institutional reform, technological innovation and market-based policy instruments (Hajer, 1995). As Huber (1995) suggests, the ‘dirty industrial caterpillar will transform into a beautiful ecological butterfly’. At the other end of the spectrum, reflexive modernity suggests that environmental risks challenge some of the central assumptions of the modern project. Rather than relying solely on technological innovation, reflexive modernity highlights the need to reconsider established notions of progress, development, governance and scientific authority. Within this perspective environmental problems become part of a broader process through which modern societies reflect upon and respond to the unintended consequences of industrial development.

Within this spectrum, natural capital and ecosystem services occupy an intermediate position. These concepts can be interpreted through both technocratic and reflexive perspectives. On one hand, natural capital accounting and ecosystem service valuation can be deployed as technocratic tools designed to incorporate environmental values into economic decision-making. On the other hand, they may also function as mechanisms through which societies critically reflect upon the relationship between human activity and ecological systems. Environmental economics and ecological economics can similarly be positioned along this spectrum. Environmental economics typically operates within the framework of ecological modernisation, seeking to correct market failures through valuation techniques and policy instruments. Ecological economics, by contrast, adopts a more critical perspective that questions the underlying relationship between economic systems and ecological limits.

Within this broader landscape surfonomics occupies an interesting position. It sits at the intersection between environmental economics and ecological economics. On one hand, surfonomics often relies on valuation techniques that reflect conventional economic approaches. On the other hand, the activity of surfing itself highlights the deep interconnections between human wellbeing, cultural values and coastal ecosystems. In this sense surfonomics simultaneously operates within existing economic frameworks while also challenging some of the assumptions that underpin them. Ecosystem service valuation can therefore be understood as occupying a space within this broader conceptual spectrum, positioned between ecological modernisation and environmental economics on one side and reflexive modernity and ecological economics on the other. The aim of this paper is to develop a framework that emphasises the reflexive dimensions of ecosystem service valuation while situating surfonomics within a broader ecological economic perspective.

8. Discussion

This paper has drawn together a number of previously separate strands of literature in order to develop a more robust evaluative position for both surfonomics and natural capital valuation. The discussion began by identifying the relationship between surfonomics and ecosystem service valuation. This connection emerged through an examination of the methodological approaches employed in both fields, revealing important overlaps as well as limitations within existing valuation frameworks. Recognising this relationship provides an opportunity not only to strengthen both fields but also to interrogate some of the underlying epistemological and methodological assumptions that shape them. Addressing these limitations within surfonomics opens the possibility of developing more innovative approaches that operate across disciplinary boundaries and different epistemic traditions.

To support this process, the paper proposed a theoretical framework grounded in sustainable development. Within this framework sustainable development functions both as a strategic vision for the future and as an epistemological lens through which relationships between society, economy and environment may be interpreted. Importantly, sustainable development is understood here as a fluid and contested concept whose meaning varies across different social, political and cultural contexts. This characteristic allows sustainable development to accommodate multiple perspectives while still providing a shared framework for discussion.

Within this context the paper has drawn together the fields of surfonomics and ecosystem service valuation. Insights from positional analysis have been used to critique conventional economic approaches to valuation while simultaneously providing a conceptual bridge between sustainable development and ecosystem services (Brown et al., 2017).

In addition, the discussion has highlighted the symbiotic relationship between sustainable development and reflexive modernity within a risk society (Borne, 2017, 2018).

Incorporating this perspective introduces a further analytical dimension that situates surfonomics and ecosystem service valuation within broader debates concerning environmental risk, governance and the future trajectory of modern societies. By bringing these strands together the paper advances both surfonomics and ecosystem service valuation. From the perspective of surfonomics, the analysis highlights the extent to which the field has relied upon methodologies derived from ecosystem service valuation. Recognising this connection allows surfonomics research to move beyond narrow economic accounting and towards more comprehensive approaches that incorporate both market and non-market forms of value.

In particular, the dynamic nature of the surf system boundary aligns closely with emerging understandings of ecosystem service valuation as non-linear and adaptive. This observation positions surfing as a particularly useful context through which to explore broader relationships between human societies and natural environments. From the perspective of natural capital and ecosystem service research, the paper reinforces the importance of recognising the multiple forms of capital that contribute to human wellbeing. The analysis emphasises that natural, social, human and built capital interact in ways that cannot easily be separated or reduced to single valuation metrics. Finally, the paper highlights important methodological implications for future research. Valuing specific surfing locations whether individual surf breaks or collections of breaks within a particular region requires a balance between detailed qualitative understanding and broader valuation techniques. Developing such approaches will allow future research to better capture the complex social, ecological and economic relationships that shape surfing environments.

9. Future Directions

There are a number of future research directions that emerge from the framework proposed in this paper. At the theoretical level, the approach developed here provides an opportunity to further explore the relationship between sustainable development and the emergence of reflexive modernity (Borne, 2018; Borne, 2026). In particular, examining the evolution of methodological approaches within the ecosystem services literature, alongside the development of natural capital policy discourses, may provide additional insights into how reflexive modernity is manifested within environmental governance. At the same time, there remains a need to continue strengthening the conceptual links between natural capital and sustainable development as mechanisms for supporting more sustainable futures. Further work that integrates these perspectives has the potential to deepen understanding of how ecosystem service valuation operates within broader sustainability frameworks.

At the policy level, the framework proposed in this paper offers a tool that can be applied to existing policy contexts in order to examine how natural capital valuation is deployed within particular governance arrangements. In doing so, the framework makes it possible to identify the broader economic and epistemological assumptions that shape valuation processes in different contexts. This approach also provides stakeholders with a mechanism for critically examining the underlying assumptions embedded within governance and valuation practices. By situating natural capital valuation within a broader theoretical framework, it becomes possible to better understand both the intentions and the potential implications of these approaches within specific environmental and policy contexts.

More broadly, the framework developed in this paper contributes to ongoing debates surrounding the valuation of natural resources and the role of ecosystem services within sustainable development. By situating surfnomics within a wider conceptual landscape that incorporates sustainable development, positional analysis and reflexive modernity, the paper highlights the limitations of narrow economic valuation approaches when applied to complex socio-ecological systems. What this demonstrates is that the value of surfing environments

cannot be fully understood through conventional economic metrics alone, but must instead be interpreted through a broader framework that recognises ecological, social and cultural dimensions of value. In this sense, surfing environments provide a valuable lens through which broader questions surrounding the valuation of nature, sustainability governance and human environment relationships can be explored

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