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Where space is created societal values are generated – The case of the Sand Engine

Heleen Vreugdenhil[a,b], Jill Slinger[b,c]

[a]*Deltares, P.O. Box 177, 2600MH Delft, the Netherlands*

[b]*Delft University of Technology, Faculty of Technology, Policy and Management, P.O. Box 5015, 2600GA, Delft, the Netherlands*

[c]*Institute for Water Research, Rhodes University, P.O. Box 94, Makhanda 6140, South Africa*
email: heleen.vreugdenhil@deltares.nl

Abstract

A large sandy peninsula and beach were realized in Dutch coastal waters in the Sand Engine pilot project. In addition to the benefits for flood protection, the Sand Engine generates multiple other societal values. It provides a new type of landscape of uncommon size along the Holland coast where nature, culture, history and the future come together. In this article we discuss the added value of the Sand Engine for culture and the arts, its iconic value and the development of knowledge in diverse sciences, most notably morphology, archaeology and palaeontology, as well as its educational function. We explore how different governance modes can influence how the added value is generated and what type of societal value arises. We distinguish four different governance modes related to the level of control exercised by authorities: directive, co-creational, facilitatory and observational. Different modes can co-exist and may change over time. For the Sand Engine we find that the knowledge development was highly directed, archaeology and palaeontology were facilitated, while an observational mode was employed towards arts and culture. The study leads to the inference that when the physical and societal space is created, societal value-added initiatives emerge.

Keywords: Arts and culture, Scientific progress, Education, Landscape innovation, Modes of governance, Dutch coast.

1. The Sand Engine – A landscape innovation

In 2011 the Sand Engine pilot project was realized. The Sand Engine is an innovative, large-scale sand nourishment in front of the Dutch coast. In total 21.5 million m^3 of sand was deposited on the coast with the idea that such a mega nourishment would make frequent smaller nourishments less necessary and that this would benefit the sandy coast

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ecosystem. Moreover, new nature and an extensive recreational area would become available. Over time, waves, wind and currents would dissipate the sand of the Sand Engine, spreading it along the shore and so protecting the coast against erosion and strengthening the dunes (Huisman et al., 2019; Oost et al., 2016; Taal et al., 2016).

The Sand Engine can be viewed not only as a biophysical landscape transformation but also as a landscape innovation aiming to deliver diverse benefits to society. Although extensive evaluation of the biophysical and flood safety aspects of the Sand Engine have taken place (Huisman et al., 2019; Oost et al., 2016; Taal et al., 2016), little attention has been paid to the realization of other societal values. This contrasts with other nature-based innovation projects, particularly internationally, where the diversity of societal benefits is emphasized (see Bockarjova et al., 2022; Slinger, 2021). The aim of this article is twofold, namely: (i) to highlight the added value to society achieved by the Sand Engine, particularly the values that are mostly not envisaged by the coastal management practitioners and engineers designing and implementing the project, and (ii) to discuss factors, particularly governance roles, that contribute to generating such societal value.

After highlighting the different modes of governance that can be applied in the design and management of large-scale landscape innovations (Section 2) and describing our approach (Section 3), the article moves on to describe the societal values generated by the Sand Engine including culture and arts, the iconic value, palaeontology and archaeology and knowledge and education (Section 4). Then, both physical and non-physical factors contributing to the realization of societal value are discussed (Section 5). Finally, we discern the governance roles applied in the Sand Engine pilot case and discuss their role in the realization of societal value (Section 6).

2. Theoretical background – Governance modes for landscape innovation

The emergence of societal value is not random. It can be influenced or steered by the roles that governmental bodies adopt and constrained or enabled by the existing societal landscape. The role of governmental organizations in relation to society is widely discussed within the public administration literature (see Nederhand et al., 2019). In a study for the Province of South Holland, Meun et al. (2018) drew upon the work of Van der Steen et al. (2014) to identify the roles that the province can adopt in developing and implementing policies. Their categories can be distinguished as differing along two axes: (i) from a hierarchical to a cooperative mode of governance, and (ii) from a proactive to a reactive stance in relation to society. After determining these axes, we build upon these characterizations to discern four governance modes applicable to landscape innovations: directive, co-creational, facilitatory and observational (see Figure 1 and Table 1).

In the directive mode, the initiator (either a government or a private party) is proactive and controlling. They decide what happens and who is involved. It is a predictable and intensive trajectory for the initiator. In the co-creational mode of governance, a large group of stakeholders is involved in designing the intervention. The government contributes to

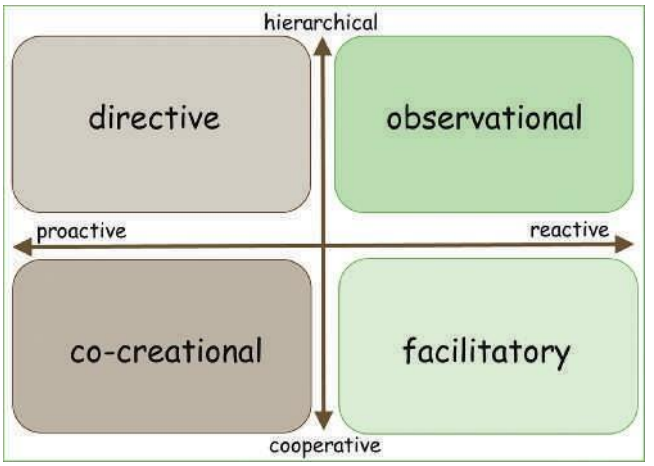

Figure 1. Four governance modes applicable to landscape innovations.

Table 1
Four governance modes for landscape innovations

Mode of governance	Initiative	Role of government	Project phase	Conditions	Expected consequences
Directive	Government	Proactive, control	Design and Management	Clear arrangements and division of tasks; organize activities	Predictable; intensive
Co-creational	Large group (potential) stakeholders	Serving the process; coordinating, not leading	Design and Management	Make time and knowledge available; skills in participatory engagement required	Highly creative and high level of societal embedding; intensive
Facilitatory	Societal stakeholders	Reactive, supportive	Management	Make (financial) means available	Dependent on external initiatives; extensive
Observational	Societal stakeholders	Absent, auditing	Design and Management	n.a.	Very dependent on external initiatives and institutional playing field

the process by bringing parties together and coordinating, but not leading. This can result in a high degree of societal embedding, but also asks for space for surprises and flexibility about who is involved when (d'Hont, 2020; d'Hont & Slinger, 2022; McEvoy et al., 2019; Slinger, 2021). In the facilitatory mode of governance, the government is primarily reactive, supporting and leaning on external initiatives. No active role is adopted by the government in steering the process to achieve societal goals. In the fourth mode of governance, the observational mode, the government merely watches what happens and tests

whether initiatives conform to legislation. As our characterization needs to be applicable to land- and waterscape innovations, we differ in this category from the characterization of Meun et al. (2018) which is oriented to the role of the government in ensuring routine regulatory adherence. Here we define a looser, somewhat distant and impartial governance role because the goal is to explore landscape innovation rather than implementing policies and their associated regulations.

The different governance modes can play out differently in diverse social contexts. Where there is a high degree of accessibility to the landscape area, high population densities and strong institutional networks, we note that taking a directive role means that the many activities will be organized by the initiators (government agencies) that are well visited by a wide audience. However, there is less space for spontaneous activities and activities tailor-made to the stakeholders. In the co-creational mode, there are also many activities organized, but these are tailor-made. Because there is a risk that some stakeholders are missed out, there is an obligation to monitor for inclusion. In the facilitatory mode, there are many projects, but the extent to which these are inclusive from a societal point of view is uncertain. Fields that are less well organized may be neglected. In the observational mode, the uncertainty regarding initiatives is high, but there are likely many and diverse private initiatives requiring regulatory checks or auditing.

3. Approach – Determining the societal value of a landscape innovation

Determining the value people derive from landscape innovations requires moving beyond analysing the direct biophysical benefits to consider the cultural and societal benefits. For instance, societal values generated by the Sand Engine include opportunities for education and contributions to cultural heritage and knowledge systems (see Costanza et al., 1997; Bockarjova et al., 2022; Milcu et al., 2013). Accordingly, a mixed-methods approach involving three interview rounds, documentary analysis and a database search was adopted to gather information (Vreugdenhil et al., 2021). In particular, eight initial interviews were held in 2020 with officials from five key governmental and knowledge organizations selected on the basis of their involvement in different phases of the Sand Engine project from its inception to the present day. This was followed by a second round of interviews with additional people identified in the first round as using the Sand Engine in different ways such as artists, educators, scientists, policymakers and terrain managers. A third round of interviews followed with societal actors who were identified as deriving value from the Sand Engine in the second round. This led to nineteen interviews in total.

In the interviews seven themes were addressed: culture, iconic value, archaeology/palaeontology, spatial planning/economy, knowledge, network development and education. Depending on the respondent a selection of these themes was made, leading to five to six questions. The interviews were semi-structured and took place at the Sand Engine or online. For more detail, see Vreugdenhil et al. (2021).

These interview data were then analysed and cross-compared with documentary evidence and data deriving from regular monitoring campaigns, for example, the recreational

monitor (Goossen et al., 2020), for validation purposes. To validate claims regarding the knowledge output, an explorative database search in Scopus and Google Scholar was conducted on the scientific outputs related to the Sand Engine. The key words searched were: 'Zandmotor', Sand Engine' and 'Sand Motor' in title, key words or abstract. Articles that discuss sand nourishments on the Dutch coast, but do not explicitly use the term 'Sand Engine' were therefore not included. A total of eighty-eight scientific publications (articles and conference proceedings) were identified, including publications provided by interview respondents. As some interviewees had an archaeological, palaeontological and governance background, these scientific areas may be over-represented compared to other research fields such as education or ecology.

The outputs of the analysis are described in detail by Vreugdenhil et al. (2021). Additionally, the recreational and economic values were addressed by Wienhoven et al. (2020) and Goossen et al. (2020). This synthesis information on the societal values generated by, and on, the Sand Engine is then utilized in exploring how modes of governance can influence the social value generated by a landscape innovation.

4. Societal values generated by the Sand Engine

Besides generating biophysical benefits, the Sand Engine has generated added value for society. Milcu et al. (2013) and Bockarjova et al. (2022) classify such effects as cultural ecosystem values, and include recreation and associated economic values. We are particularly interested in cultural and artistic activities, its iconic value and its effects on archaeology and palaeontology, knowledge and education as described in the following sub-sections.

4.1. Culture and arts

In terms of cultural value, the Sand Engine has provided a physical place with site-specific characteristics that have inspired diverse artists to create art on the Sand Engine, including large sand drawings, sand glass, sea meal tastings and tidal fabrics (see Figure 2 and www.nicolaan.nl or www.satellietgroep.nl). The Sand Engine has also appeared in several TV programmes addressing the cultural identity of the Netherlands and has inspired architects to design an ephemeral visitor centre. In addition to creating art (and artefacts), some artists also use the Sand Engine experientially to connect people and nature and to create climate awareness: "The Sand Engine is a gift. A unique opportunity to feed the wider audience with knowledge, experience and imagination about this special and innovative coastal landscape. There are numerous opportunities to connect people and nature" (pers. comm. Heerema. translated into English by authors). New art and activities have arisen by connecting people from science, art, politics, schools, coastal localities and the general public. These include excursions and educational workshops. The results are displayed in exhibitions, lectures and essays with artists indicating that the Sand Engine has boosted their work.

Figure 2. Sand drawings on the Sand Engine by Nico Laan. Title: Geometric Illusions, June 2021, 60 × 40 metres.

4.2. Iconic value

An icon symbolizes or is a figurehead for a concept or idea. It is a famous object for at least a specific group and distinguishes itself by its symbolic or aesthetic value (Mouter & Heijnsdijk, 2016; Verheul, 2012). In this sense, the Sand Engine can be considered an icon. It is the figurehead of Building with Nature with adagio like 'not hard but soft', 'dynamic management' and 'using natural processes'. Furthermore, it is of extraordinary large size relative to other sand nourishments and is famous amongst coastal engineering professionals (Bontje, 2017). It is considered to demonstrate the leading role of the Netherlands in coastal engineering (Bontje & Slinger, 2017). The iconic value is confirmed in communication about the Sand Engine by involved people in statements like: "It is an icon that appeals to many" (Van Thiel de Vries, in Baltissen, 2015, p. 55) or "… a very beautiful iconic project of building with nature and with sand" (Nijhof, idem p. 32). In addition to shared pride and inspiration, the iconic value leads to other social values. Dutch government authorities and companies use the Sand Engine as an example case when communicating with international partners or potential clients and take delegations to the field. Educators in Dutch secondary and tertiary education use the Sand Engine to attract students and allow them to experience coastal dynamics, biology and climate change.

Despite the expressed iconic value amongst professionals, the iconic value for a broader audience at the national and international level is limited. Results from the latest recreational monitor, a survey conducted amongst beach visitors in 2020, show that most visitors are local. Only few come from the rest of the country, or abroad. Furthermore, people visiting nearby beaches are often unaware of the Sand Engine (Wienhoven, 2020). To the broader audience the Sand Engine is still an undiscovered pearl.

4.3. Archaeology and palaeontology

The Sand Engine and Maasvlakte II (Port of Rotterdam) are the primary places in the Netherlands for finding fossils originating in the North Sea. Every day new findings are made in the sediment deposited in these locations, after having been mined from the North Sea. In combination with improved fossil research techniques this makes the Sand Engine of immense value for archaeology and palaeontology. The Sand Engine is of particular importance because relatively small objects can be found. In the past, fishing boats found many large bones from mammoths, for example, but on the Sand Engine smaller objects were found for the first time. At the same time it needs to be noted that these objects could be found because they have been removed from their original location in the North Sea. So, archaeologists and palaeontologists are excited about the increase in knowledge the Sand Engine has provided, but are aware that keeping historical items at their original location is the best practice.

Amongst the most special findings is a piece of flint with birch pitch (see Figure 3). This 50,000-year-old artefact has changed our current view on the Neanderthals. It indicates a higher level of intellectual capacity than assumed so far because producing the birch pitch requires an understanding of chemical and technical processes, particularly in an era where trees were not abundantly available (Niekus et al., 2019). Other findings, including human bones, spearheads and tools from the Mesolithic period, demonstrate that humans were already regular inhabitants of the Netherlands after the last Ice Age.

Figure 3. Neanderthal flint with birch pitch found at the Sand Engine. (Photo credits: Rijksmuseum van Oudheden.)

Figure 4. Fragment of the mandible of a giant deer found at the Sand Engine. (Photo credits: Bram Langeveld, Rotterdam Natuurhistorisch Museum.)

Fossils of fauna up to 120,000 years old have been found. These include fish and bird species, and sea and land mammals from the Pleistocene and Holocene periods, such as the steppe wisent and the woolly rhinoceros (see Figure 4 for an example of a finding). Important insights include: that the giant auk was part of the ecosystem of the North Sea (Langeveld, 2020); that the monk rob that now only lives in the Mediterranean is tolerant to colder conditions (Mol & Langeveld, 2017); and that the red deer still exists thanks to its ability to adapt its diet to new circumstances (Langeveld et al., 2020). Other animals that were less able to change their diet like the steppe wisent became extinct (Van Geel et al., 2019). The development of new research methods, such as studying the pollen in fossil molars to learn about the diets of animals, underlies the development of these new insights.

Findings from the Sand Engine have allowed several museums to expand exhibitions or even develop new exhibitions based on the findings, including the Natuurhistorisch Museum Rotterdam, and the Rijksmuseum van Oudheden and Naturalis in Leiden. Additionally, new apps, websites and educational programmes have been developed to share the knowledge with a wide audience. Examples include the app 'oervondstchecker' and the site www.fossiel.net where people can verify what they have found. In general, the cooperation between museums, amateurs and scientists has been strengthened through the Sand Engine. Clearly the Sand Engine has a recreational value for amateur archaeologists and palaeontologists.

4.4. Knowledge development

The Sand Engine has contributed to scientific and operational knowledge development. There was and is substantial attention for monitoring and analysis of the pilot project with diverse Dutch and European research funds awarded for research, and private investments

also contributing. An example is the NatureCoast Research Programme (Luijendijk & Van Oudenhoven, 2019).

Not surprisingly, most of the eighty-eight scientific publications identified in the database search focus on morphology as this was the primary focus of the first research projects. To a lesser extent and in later phases, there is attention for palaeontology and archaeology, governance and ecology (Figure 5). The concept of

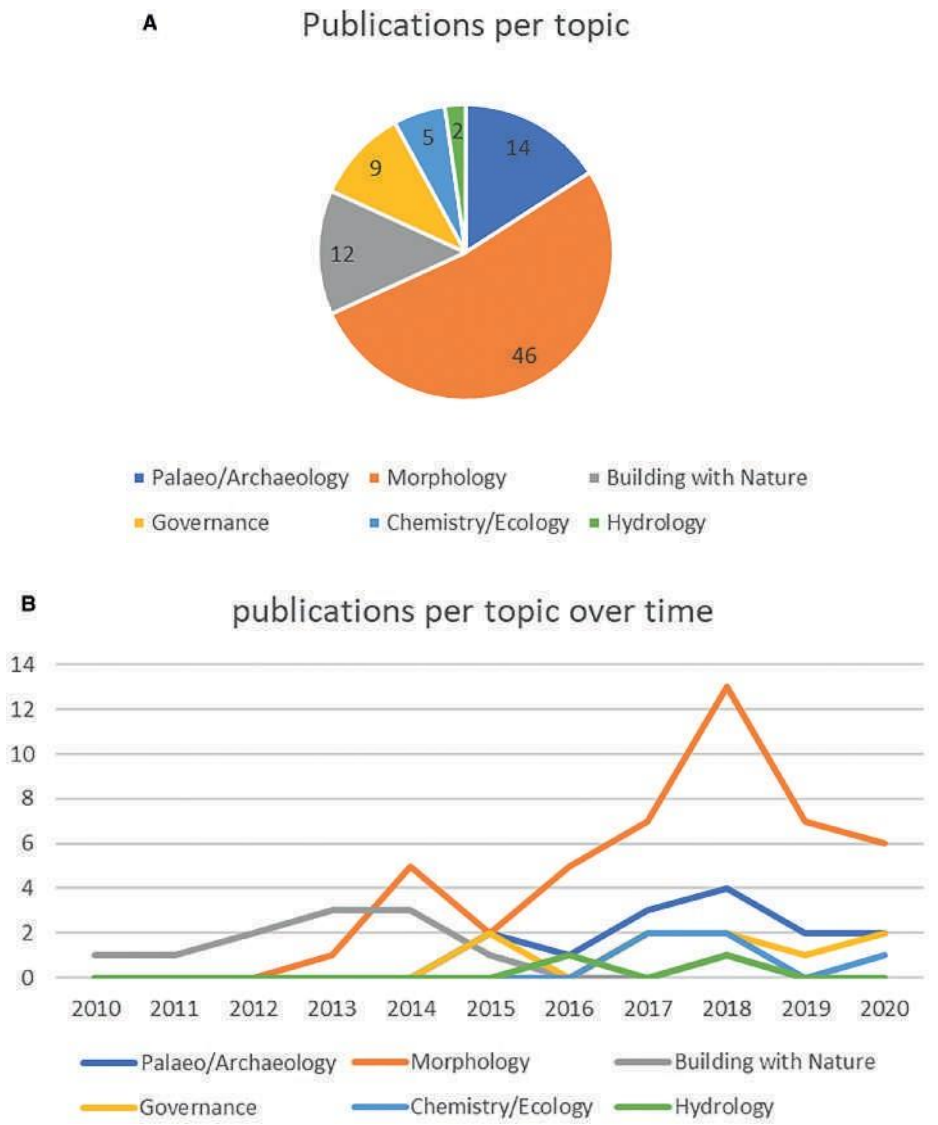

Figure 5. The total number of publications on the Sand Engine between 2010 and 2020 (A) and the distribution of the publications per topic over time (B).

Building with Nature as a management strategy received most attention in the early phases of the Sand Engine while there was international interest for its application at a later stage.

The scientific knowledge developed in the Sand Engine pilot has been used for new projects in several ways. For example, projects in Ameland and Bacton have been inspired by the Sand Engine, utilizing not only an understanding of biophysical processes but also managerial knowledge on how to organize monitoring and data management. Furthermore, the swimmer safety app developed for the Sand Engine will be applied in other Dutch coastal towns, and new coastal programmes are more inclined to directly start a dialogue with inhabitants. In Sweden, the story of the Sand Engine supported the discussion to implement a sand nourishment in Ystad (Bontje et al., 2019). Above all, respondents indicated that the Sand Engine has strengthened the network between universities, government and other partners, both in the Netherlands and abroad. Papers and presentations have been developed jointly and experiences shared – also from abroad to the Netherlands. The stronger ties have also led to the development of new research proposals such as the Partnership in Research and Education (PIRE) between Texas and the Netherlands (Brody et al., 2022).

4.5. Education

The Sand Engine contributes to knowledge transfer as it serves as a vehicle for education. It is used at all levels of education: primary education, secondary education and universities. For instance, it served as the focal case study in the massive, open online course on edX ‘Engineering: Building with Nature’, which has reached over twenty thousand participants (Slinger, 2021). Secondary schools from The Hague undertake school expeditions to the Sand Engine, while pre-prepared educational packages are available for primary schools financed by the Province of South Holland. Around forty school classes have visited the Sand Engine in 2021 (pers. comm. by the Province of South Holland). Besides the formal education system, several private initiatives also use the Sand Engine for educational purposes. Government bodies, nature organizations, museums and other private associations have developed educational material and television programmes and give excursions on the Sand Engine. Examples thereof are the Zuid Hollands Landschap, IVN, Belevenisonderwijs, SchoolTV, Rijksmuseum van Oudheden, Naturalis and Nationaal Park Hollandse Duinen.[1]

[1] https://www.zuidhollandslandschap.nl/activiteiten/excursie/dieren-op-de-zandmotor (visited 28-11-2023), https://www.ivn.nl/afdeling/den-haag-en-omstreken/natuuractiviteiten/excursie-zandmotor/ (visited 28-11-2023) https://belevenisonderwijs.nl/strandexcursie, https://schooltv.nl/video/de-kennis-van-nu-in-de-klas-wat-is-de-zandmotor/ https://www.rmo.nl/tentoonstellingen/tentoonstellingen-archief/doggerland/, https://www.naturalis.nl/educatie/basisonderwijs/bewijstijd, https://www.naturalis.nl/educatie/basisonderwijs/bewijstijd, https://www.nationaalparkhollandseduinen.nl/activiteiten/het-zeeleven-op-de-zandmotor/.

5. Factors contributing to societal value

Both physical and non-physical factors contribute to the generation of societal values by the Sand Engine. The physical factors include the Sand Engine's physical design, its location and the material used. The non-physical factors include management choices prior, during or after realization as well as contextual societal factors such as welfare and education levels, and whether subsidies are available and institutional networks exist.

5.1. Physical factors – Location, physical design and the material used

The Sand Engine adds a relatively large sandy space that people can use freely to a densely populated region. The connection to the beach, its position above water and the proximity to The Hague make the area readily accessible to a large number of people. These include both researchers who study the area and recreational visitors who walk their dog or view the dune development, for example. These conditions also make it an attractive area to visit with international professional or political delegations who may have limited time available. Other projects in the Netherlands that are similarly interesting from a nature-based solutions perspective (e.g. Kleirijperij in the northeast, Hondsbossche Duinen in the northwest and Marker Wadden islands in the north-central area of the Netherlands) receive less visitors both from the general public and professionals, because the locations are less accessible, and they are further away from the political and economic centre of the Netherlands.

The large distance from the dunes to the water has ensured that the hook-shaped Sand Engine is also a relatively quiet place on the regional coast. Particularly the 'hook' was quiet in the first years. This provided room for functions like education and art, not only because of the physical space but also because the natural dynamics like the winds, tides and sedimentary processes on the Sand Engine could be experienced and used in artistic and educational activities. The lake on the Sand Engine contributed to the development of the recreational activity of kite surfing in the Netherlands.

The accessibility in combination with the source of the sand makes the Sand Engine attractive to archaeologists and palaeontologists, both professionals and amateurs. Using sediment sources from the Eurogeul area in the North Sea (Luijendijk & Van Oudenhoven, 2019) means that there are many fossils present at the Sand Engine. This benefit to archaeology and palaeontology was not taken into consideration in the choice of the original mining area.

5.2. Non-physical factors

Management choices preceding, during and after realization can influence the societal values generated by the Sand Engine. For instance, a management choice made during the realization of the Sand Engine was to go beyond the regulatory requirement

for archaeological exploration and to open the area to a wider group of archaeologists and palaeontological researchers at an early stage. This contributed to early findings and raised the enthusiasm to search for fossils. Other management choices include the absence of zoning for nature and recreation, the cleaning regime (how often, how) and information supply (what, how, where). These choices contribute to society's experience, knowledge of and interest in the Sand Engine, and often entail trade-offs. For instance, the absence of zoning leads not only to broad accessibility but also to lower quality nature experience.

Contextual social factors that contribute to the societal value of the Sand Engine include welfare and well-being levels, educational levels, the availability of funding for activities and the network for organizing activities or arranging collaboration. When the welfare, well-being and education levels are high, people have more interest in visiting the Sand Engine (Goossen et al., 2020). More vulnerable groups barely visit the beaches.

The availability of subsidies can facilitate starting up projects for science, education or culture. Without subsidies many projects would not have started, or different funding mechanisms would have had to be found. The presence of institutional networks enhances the speed with which activities can be organized and determines the extent of such activities. A good example is the manner in which the archaeological and palaeontological field is organized between museums, universities and amateurs. Amateurs play a key role in field work, which could otherwise not be financed. Through institutional networks they often share their finds with museums and jointly determine the potential scientific relevance of a discovery. When it is found to be worthy of further investigation, scientific specialists are called upon.

6. Discussion on the role of governance in generating societal value from the Sand Engine

By creating a new physical space, the Sand Engine in the Netherlands has generated diverse and often unexpected societal values. Both physical and non-physical factors contribute to this. It is noteworthy that most of the societal value that was generated, apart from the knowledge development fall within the scope of coastal engineering and management, was not planned, steered or financed by the government authorities of Rijkswaterstaat and the Province of South Holland—the initiators of the Sand Engine. Instead, the process of generating societal value appears to have happened almost autonomously. However, the emergence of societal value is not random. As explained in Section 2, it can be influenced or steered by the roles that governmental bodies adopt and constrained or enabled by the existing societal landscape.

In analysing the Sand Engine pilot project, we observe that multiple modes of governance of this landscape innovation existed parallel to each other. The governance mode applied to the monitoring was directive, the mode adopted for scientific knowledge

development was facilitatory, while the governance mode adopted for other uses such as arts, culture and archaeology was mainly observational. This accords with Meun et al. (2018), who suggest that multiple modes of governance can exist in parallel and that different modes can be adopted over time.

In particular, we found that a strong directive mode of governance was not needed to gain societal value from the Sand Engine. Much of the value was generated 'autonomously' – where space was created, societal value was generated. In other words, when the government adopts the observational mode of governance, many other stakeholders take the initiative to organize activities. Such an observational governance mode provides space for spontaneous developments more diverse than those created by a single actor. However, this analysis reveals that the choices made regarding governance mode do have consequences for the societal values that are generated.

Many stakeholders feel that the Sand Engine could have generated even more societal value if other governance modes had been adopted at times – for example, in reaching more visitors from outside the region, more schools or broadening the iconic value from professionals to a broader audience. A specific example is the Argus mast located on the Sand Engine, but closed to the public for safety reasons. Proponents of the idea of using it to create a Panorama Mesdag experience with a 360° view on the Sand Engine (https://www.museum.nl/en/museum-panorama-mesdag) argue that the primary focus in the design and management of the Sand Engine was unjustifiably on professional organizations and developing a professional climate awareness. Arts, culture, schools and the general public were not considered from the beginning, even though a wider audience can enrich the design or use, and influence policymakers and scientists (d'Hont, 2020; Eldred, 2016; Schnugg & Song, 2020). Both Rijkswaterstaat and the provincial authority did not actively invest in this. Instead, Rijkswaterstaat considered itself a facilitator in terms of societal values. Values like art and culture were not considered to fall within their responsibilities. The provincial authority was reluctant to promote the Sand Engine too much as they wanted it to be a quiet place. Underlying the limited attention paid to reaching a wider public is the fragmentation in ministerial tasks (Biesbroek et al., 2011). By focusing on attaining their specific tasks, other interests or perspectives are not automatically included or are even put aside as being outside their responsibilities and influence (Janssen et al., 2020). This implies that attention should be paid to the integration of ministerial responsibilities when initiating specific landscape innovations. Indeed, a co-creational or facilitatory mode of governance is critical to gaining more societal value and connecting the Sand Engine more effectively to society (d'Hont, 2020; McEvoy et al., 2019; Slinger, 2021; d'Hont & Slinger, 2022).

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