A multidisciplinary perspective on the natural quality and rights of river systems

Would granting legal rights to the Ems-Dollard estuary in Northwest Europe benefit the natural system?

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The characteristics of the natural system of the Ems-Dollard and its governance will be published in concise form in Gilissen et al. (2019, in prep.)

Abstract

Granting rights to nature or legal personhood to natural objects as a means to improve the position of nature relative to other (societal or economic) interests has increasingly gotten attention worldwide, but thus far, there are no precedents of rights of nature in Europe. The debate mainly concerns the legal or socio-cultural implications of rights of nature, while a scientific perspective on the matter is still lacking. This study focusses on a transboundary river system in northwest Europe, the Ems-Dollard, where the deteriorated (eco)system has become subject of restoration and re-naturalisation plans under the EU Water Framework Directive and Habitats and Birds Directives.

Over centuries, the shape of the estuary was formed and evolved under (indirect) influence of anthropogenic activity. Since the 19th century however, construction works such as weirs and deepening and straightening of channels, have altered the riverine and estuarine system beyond its natural hydromorphodynamic balance. Hyper-turbidity and a deteriorated eco-system are among the most prominent consequences. The processes and characteristics of a naturally functioning Ems-Dollard are determined and form the "needs" of the natural system on which legal rights can be based. The natural reference state or "well-being" of the Ems-Dollard, which is the aim of granting rights to nature, is difficult to define because of the long history of human influence on the natural system.

Governance and management of the Ems-Dollard is a complicated affair because of the disputed border area, the different administrative levels in Germany and the Netherlands and conflicting interests of nature, society and economics. Current policy and legislation aim to find a balance between re-naturalisation and (socio-)economic interests. Nevertheless, navigation to the harbours and an inland shipyard requires an increased channel depth and weighs heavily in the balance of decision-making. Compliance with the EU Directives has proven difficult to achieve. Shortcomings of EU directives and legislation are discussed and include the insufficient representation of hydromorphodynamics and inadequate standards for the areal extent of protected habitats.

The possibility of granting legal rights to the natural system of the Ems-Dollard was investigated to see whether this could contribute to present attempts to mitigate problems and ameliorate the state of the Ems-Dollard. On the basis of examples of rights of nature and legal personhood in other countries, opportunities, limitations and implications of (i) Custodianship, (ii) Acknowledgement as a natural entity and anchoring rights in legislation, and (iii) Legal personhood are discussed. Given the framework of European and national legislation, the most feasible option for the Ems-Dollard was found to be improvement of legislation in terms of warranting the naturalness of the riverine and estuarine system.

The findings of this study and the state and future of the Ems-Dollard are discussed from a multidisciplinary perspective, that includes contemplation of the role and influence of humans in a natural system, the view towards the naturalness of the system, and whether Science should concern itself with such matters. Perhaps the greatest challenge for the future of the Ems-Dollard is to define what its natural reference state should be, given its history and ongoing human presence. This requires interdisciplinary understanding and arguments of all aspects of the system ranging from Earth Sciences to Law, policy-making and even Philosophy. To aid future discussion, this report brings together background information from these fields of expertise.

1. Introduction

Over the past few decades there has been a distinct increase in awareness regarding the ecological state of the natural environment, driven by many cases of pollution and strong ecological deterioration. For aquatic systems in the European Union, this culminated in the formation of the Water Framework Directive (2000) and, extending towards terrestrial ecosystems, the Habitats and Birds Directives (1992, 2007). These are to provide the basis framework for improving and safeguarding the ecological state of (river) systems. In the Netherlands, for example, HDB areas often contain aquatic systems and to these areas WFD and HBD are simultaneously applicable. However, the challenges for implementation of, and compliance with these directives, prove to be a difficult and complex task (e.g. SGD Eems, 2013). It is also not certain that the WFD, HD and BD are adequate in dealing with the full scope of problems in a river system, because they are centred around the chemical and ecological components of the system, while the physical hydromorphological basis of river systems is only considered in minor detail as a necessary pre-condition. Furthermore, conflicting short-term and long-term interests of society (particularly socioeconomic interests) and nature are difficult to balance in decision-making when it comes to managing the use of waterways.

It has been proposed that granting rights to rivers on a river basin scale would put the interest of the natural aspects of the system in a stronger position against those activities that inflict damage on the river system (e.g. Stone 1972, 2010; Daly, 2012; Boyd, 2017). The most prominent precedent is the Whanganui river in New Zealand (Te Awa Tupua Act, 2017), other examples are the Yarra river in Australia (Yarra River Protection Act, 2017), Atrato river in Colombia (Atrato river ruling, 2016), Ganga and Yamuna rivers in India (Uttarakhand High Court ruling, 2017) and the grounding of rights of nature in national legislation of Ecuador (Constitution of the Republic of Ecuador, 2008) and Bolivia (Ley de derechos de la Madre Tierra, 2010). The concept of rights of nature finds its origin in the 1970s in the work of Stone (1972), but the effectuation is relatively recent, and the requirements, consequences and implications are as yet unclear.

Rights and legal personhood of natural systems are not merely a matter of paperwork or of a court room setting in case river management crosses other interests. It requires transdisciplinary understanding of the physical functioning of natural systems and also touches upon philosophical aspects of the very attitude of humans towards nature. Previous studies into legal rights or personhood have focused on the legal implications of rights of nature (e.g. Naffine, 2012; Mussawir & Parsley, 2017; Cano Pecharroman, 2018; O'Donnell & Talbot-Jones, 2018) and the mainly socio-cultural context of known cases of legal personhood (e.g. Hutchinson, 2014; Ruru, 2018). The question remains, however, to what problem legal personhood or rights of nature is a solution, whether that solution is appropriate in the way it addresses the problem at hand and whether it effectively serves the envisioned purpose, for the fundamental aim of this ecocentric approach is the protection and restoration of the balanced functioning of natural systems. Rights of nature therefore need to be based on the characteristics and processes of a natural system. In the context of rights of nature, these properties of e.g. river systems are indicated as the "will" of the river (Gilissen et al. 2019, in prep), and the balanced functioning as the "wellbeing" of the river (e.g. Te Awa Tupua Act, 2017; O'Donnell & Talbot-Jones, 2018). This may appear to be a personification of a natural system that is not goal-oriented, but this should be interpreted as a set of characteristics with the aim to define the functioning of a system in order to assign it a certain legal status. The question is which characteristics of the natural system are essential.

The present study takes the first steps into investigating what properties of a riverine and estuarine system should be included when considering granting legal rights to such a system. So far, no natural systems in Europe have been granted legal rights but the possibilities have recently come to be subject of interest (Special Issue Water International, 2019, in prep.). This study takes the Ems-Dollard in the northern border area of Germany and the Netherlands as an example for western European river systems with anthropogenic adaptations and a deteriorated ecosystem, to see if granting rights would be helpful in management towards restoration of a natural balance. The Ems-Dollard example is also discussed in concise form in Gilissen et al. (2019), together with the Western Scheldt, that has similar ecological problems but a different governance and management structure.

The Ems-Dollard river and estuary have been modified by channel deepening for navigation and the water system is constricted by various construction works, such as dikes, weirs and a storm surge barrier. Economic interests have dominated management of the Ems-Dollard for decades, with ports of Eemshaven, Delfzijl and Emden demanding navigable approach routes for ships, and a major

inland shipyard at Papenburg, from which giant cruise ships have to manoeuvre through the narrow Ems several times a year (Disco & Van Heezik, 2015). Management of the Ems-Dollard is a transboundary affair between Germany (Ems and part of the estuary) and the Netherlands (estuary). Although both countries are subject to EU directives, governance in each country is arranged on different administrative levels and the place that nature conservation takes within policy-making is not straight-forward (Gilissen 2009; Van Rijswick et al., 2010). The disagreement between Germany and the Netherlands on the precise course of the international border through the estuary complicates management of the estuary and requires attention in decision-making and management (e.g. IMP, 2016).

The case of the Ems-Dollard is explored in three steps, that cover the main aspects involved in restoration of the natural system by means establishing a custodian, rights of nature and/or granting legal personhood. The basis is the natural system itself (chapter 2). The history and current state of the river and estuary are examined, the hydromorphological and ecological problems are highlighted, and the river and estuary are defined by their characteristic properties. These properties form the "needs" or "will" of the river, which is a requirement for granting rights to a particular natural system and advocating its interests based on those rights. In chapter 3, the governance and policy-making in the Ems-Dollard region are discussed in light of the attempts to mitigate the ecological problems and ameliorate the functioning of the natural system. The degree to which these mitigation and amelioration attempts are successful or not is used as the basis for assessing the possibility of granting legal rights to the natural system. Chapter 4 covers legal aspects of rights of nature. Examples from other natural systems in different parts of the world illustrate the various approaches of granting rights to nature, including custodianship and legal personhood. The implications that such rights would have for the Ems-Dollard are discussed. This report ends with a discussion from a multidisciplinary perspective on the state and future of the Ems-Dollard system and integrates the findings from the chapters on natural sciences, governance, and law. As this study moves among a wide range of fields of research, this report is written for a broad audience and is not restricted to Earth Sciences, the home-field of the author.

2. Ems-Dollard: the natural system

2.1 Study area and history

The Ems basin is situated in the Dutch-German border area and covers 17934 km^2. The river Ems springs in Nord Rhine-Westphalia and flows through Lower Saxony into its estuary along the Dutch-German border and debouches into the Wadden Sea (UNESCO World Natural Heritage). The average discharge is ~81 m^3/s, with extremes ranging from 5 m^3/s (1947) to 1200 m^3/s (1946). The flow regime is seasonal with low discharges in summer, due to the relatively small retention area of the catchment (Krebs & Weilbeer, 2008). The Ems system can be subdivided into five parts: the Upper Ems river, the Lower Ems or Tideems which is a tidal river with unidirectional flow but tidally-modulated water levels, the tidal Dollard embayment, the mid-estuary and outer estuary. Here the purely fluvial Upper Ems river is not considered and the focus lies on the dynamics and ecological state of the tidal system, from the weir at Herbrum to barrier island Borkum (~100km), where the Wadden Sea meets the North Sea (figure 1). In this region of the Ems basin, small tributaries are the rivers Leda debouching into the Ems near Leer, and Westerwoldsche Aa into the Dutch Dollard.

The origin of the Ems system and its estuary can be traced back to the early Holocene, when the rising sea flooded the low-lying Pleistocene river valleys and the mouth of the Ems river developed into an estuary. Further rising sea levels induced large scale inland peat growth. As sea level stabilized from 5000 years BP (before present) onwards and the supply of sediment from the river continued, tidal basins in the area started to silt up. Drainage of the hinterland decreased, causing expansion of the peat lands. The land surface subsided due to natural sedimentation and compaction processes in the peat lands, facilitating ingressions of the sea. Old ingression channels in the eastern Ems area date back to 3000 years BP. In the Iron and Roman ages human settlers in the region contributed to the subsidence and ingressions by artificially draining parts of the peat lands. The major part of the present upper estuary landward of Delfzijl remained mainly supratidal and peat area from 2500-1300

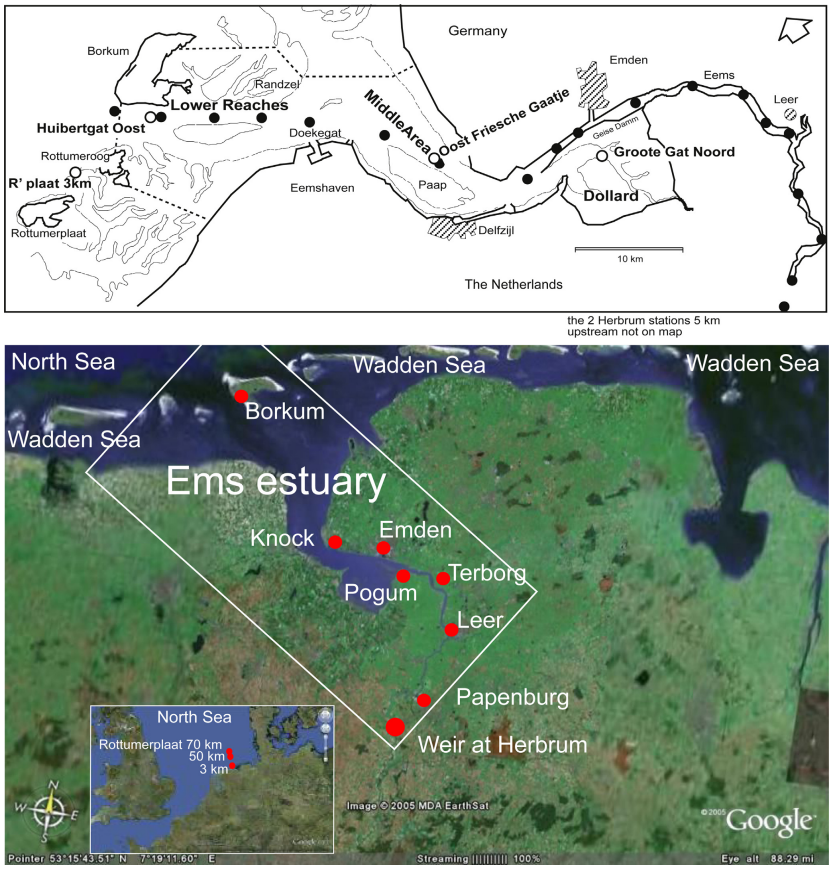

Figure 1: The location of the Ems-Dollard estuary (Source: De Jonge et al., 2014)

years ago. The extent of mudflats and saltmarshes varied with the migration of the main channel of the Ems. Far inland, the river was flanked by supratidal saltmarshes, ridges and levees.

Anthropogenic influence on landscape evolution reached a new level with the construction of dikes and the embankments of salt marshes for land reclamation from the Late Middle Ages onwards (Vos & Knol, 2015). Continuous quarrels between regents and inhabitants were fought out by intentional dike destabilisation and perforation by inhabitants. Because maintenance and repair were poor, dike failure and ingressions frequently caused disastrous floods (Stratingh & Venema 1855). A series of such floods formed the Dollard in the 13th and 14th centuries AD (Stratingh & Venema 1855; RWS, 1966) and several more storm surges enlarged the Dollard to its maximum extent around 1500 AD. With the formation of the Dollard, the area of the tidal basin greatly increased and the mouth of the Ems widened. This major change in the characteristics of the system meant that dikes had to be moved backwards (RWS, 1966).

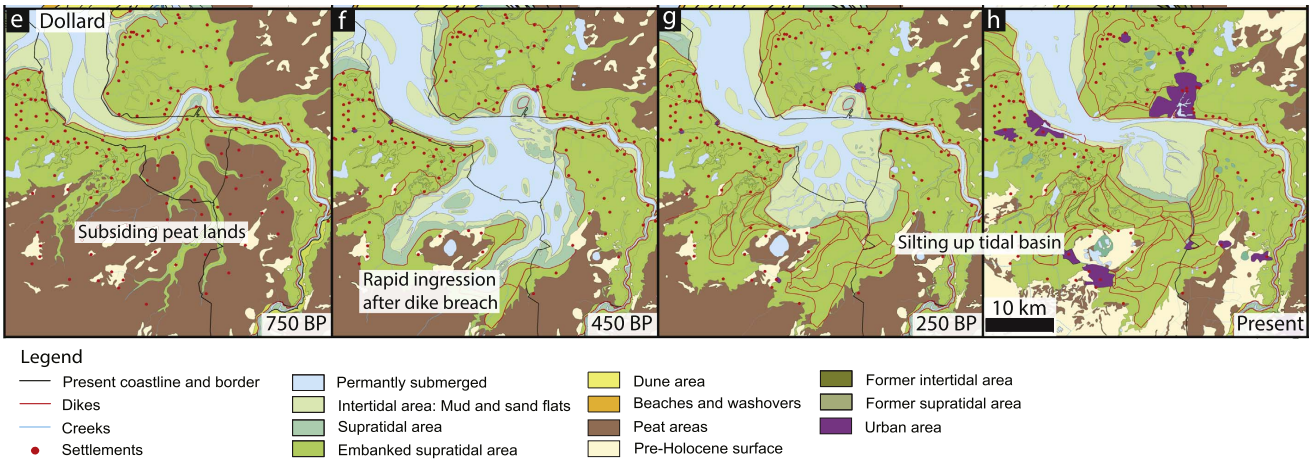

Figure 2: Evolution of the Ems-Dollard estuary. Ages in years before present (Source: De Haas et al., 2018, from Vos & Bungenstock, 2013)

During the following centuries, connections with the sea (inlets) enlarged or narrowed, and in the estuary, channels aggraded and migrated (figure 2). Sedimentation processes filled in the estuary, reducing its tidal basin surface area by 40% since 1650 (Van Maren et al., 2015a). Weirs and sluices were constructed in the tributaries to control drainage of the hinterland, these older structures were quite basic, but as technology and construction advanced, they were replaced by more permanent works. Major construction works in the Ems commenced in 1872 when several groynes were constructed, most notably the Geise dam, that directed the Ems channel along a course partly separated from the Dollard.

Navigation on the Ems and its estuary became important from 1500 AD onwards, an important benchmark is the opening of Emden Seaport in 1901. In order for larger ships to reach the harbour, Gatjebogen was dredged and the East Frisian Gatje was deepened (Krebs & Weilbeer, 2008). The first streamlining operations in the Tideems began in the late 1890s (Herrling & Niemeyer, 2015). During the 20th century, increasing navigation activity and draught of the ships heralded in a series of thorough measures of channel straightening (streamlining), deepening and dredging in the Ems-Dollard system. The cultivation of peatland and heathland to promote economic development in northwest Germany under the Emslandplan (1950) contributed to the changes in the water system and drainage, but the adjustments in the river and estuary were most prominent. The Tideems was shortened by a total of 15% in the various operations to cut off bends in the meandering river (Herrling & Niemeyer, 2015). The guaranteed safe water depth for shipping in the outer Ems was increased from 7m in 1956 to 15.5m in 2011, and upstream from Emden the fairway depth almost doubled in only 25 years, from 4.5m in 1980 to 8.2m in 2005 (De Jonge et al., 2014). Deepening operations in the Tideems were undertaken for inland navigation. The depth of the Ems near Papenburg was 4m below mean high water after World War II (Krebs & Weilbeer, 2008) and was deepened in the 1980s and 1990s to 7.3m by 1995, for the benefit of passage of ever larger ships towards the shipyard in Papenburg (Bos et al., 2012).

Dredging has been standard procedure to keep the outer Ems navigable throughout the year and the harbours accessible, and in the Tideems for navigation inland and to the shipyard in Papenburg (Krebs & Weilbeer, 2008). The majority of dredged sediment is stored on land, the rest is dispersed within the estuary, at locations in the seaward area. At the height of dredging works in the 1970s and 1980s up to 18 million m^3 of sediment was dredged from the Ems-Dollard in a year, which has now decreased to ~10 million m^3. Of note are the removal of boulder clay from the channels in the lower estuary between 1970-1979 (De Jonge et al., 2014) and the change in strategy of Emden harbour in 1994, from dredging to reaeration of the sediment to prevent consolidation and keep the harbour navigable (Van Maren et al., 2015a). The dredged sediment changed in composition over the years, with a considerable increase in silty sediments (Krebs & Weilbeer, 2008). The most prominent construction works in the Ems-Dollard are the Geise dam that was reinforced in the 20th century (Krebs & Weilbeer, 2008), the weir at Herbrum that marks the boundary from the Tideems to the upper Ems, and the Emssperrwerk, a storm surge barrier at Gandersum. Since 2002, the Emssperrwerk regulates water levels and is closed in case of predicted storm surges over 3.7m above NAP (FGE Ems, 2015) or in order to raise water levels for the passage of cruise ships from the inland shipyard several times a year (Disco & Van Heezik, 2015).

2.2 Hydromorphodynamics

Hydromorphodynamics in rivers and estuaries are determined by the body of the system in which sediment supply, discharge and tide act as (external) drivers that shape the distribution of sediment and flow in the formation of channels, bars and tidal flats (Pritchard, 1967; De Haas et al., 2018). Sediment is mainly supplied by the Wadden Sea and North Sea and transported upstream through the estuary and into the Tideems (Van Maren et al., 2015b). Fresh water flows in from the Ems river and is important for the redistribution of sediment. During high discharges it should flush out sediment from the Tideems back to the estuary (De Jonge et al. 2014). As the body of the Ems-Dollard has been extensively modified by human interference while the external drivers have remained fairly constant, the hydromorphodynamics have adjusted accordingly. The main changes of influence on the hydromorphodynamics are the deepening of the channels, the location of sluices and dams, streamlining and dredging (Bos et al., 2012; Van Maren et al., 2015a). The estuary has been a (natural) sediment sink for centuries and filling up with fine sediment, especially the Dollard. Infilling has

reduced the surface area of the estuary by 40% since 1650 (Van Maren et al., 2015a), and the tidal basin has thus become smaller. The Dollard at present is at pace with sea level and does not provide much extra accommodation space for sediment settlement, until sea level rises further, which it will due to climate change (P. Dankers, pers. comm.).

The body of the estuary including the shape of the channels has essentially been preconditioned by human engineering, with dredging maintaining channel depth and dikes keeping the outline in place. Additionally, layers of fluid mud have developed on the bed since 1995, and the concentrated but mobile slurry migrates along the estuary over a distance of 10 km (Van Maren et al. 2015b). This very fine sediment could partly originate from seas and basins outside the estuary or from the Tideems, but is probably mainly due to dredging and disposal of dredged sediment, as the initial formation coincides with the changed dredging strategy in Emden harbour (De Jonge et al., 2014).

2.2.1 Tides

The Ems-Dollard tidal system is dominated by the semi-diurnal lunar tide component and its first overtide (M_2 and M_4, respectively) (Schuttelaars et al., 2013) that drive tidal flow through the estuary up to the weir at Herbrum. The tide is asymmetric with a longer highwater slack (Van Maren et al., 2015b), that varies along the length of the estuary and is less pronounced during periods of high river discharge (Winterwerp et al., 2017). The asymmetry has amplified during the last decades due to channel deepening and reduction in friction due to increased mud content (Chernetsky et al., 2010). The straightened and deepened single channel system combined with the fluid mud layers eases flow through the estuary because of the reduced resistance from the bed and fewer bends, which essentially propels the tidal wave inland leading to a much larger tidal amplitude upstream (Schuttelaars et al., 2013). Tidal velocities increased since 1937 (Herrling & Niemeyer, 2008).

Furthermore, the location of the weir at Herbrum reduces the length of the estuary (currently ~55km) to match the frictional length of the tidal wave and causes resonance with the tidal wave, maximizing its amplitude (Chernetsky et al., 2010; Schuttelaars et al., 2013). For a smaller estuary length, the tidal wave would be a standing wave of which the amplitude would increase with distance to the sea. For lengths sufficiently larger than its current length, the tidal wave would propagate inland as a propagating wave, with amplitude decreasing with distance to sea and thus lower inland water levels (Schuttelaars et al., 2013). Resonance is not only related to estuary length, but also to channel depth and bed friction (Chernetsky et al., 2010; Schuttelaars et al., 2013).

As a result of the combined circumstances, the tidal wave amplitude at Papenburg has strongly increased from 1.6m in 1950 to 3.6m in 2010, while the natural tidal wave amplitude at barrier island Borkum only increased by ~0.10m during the same period (Herrling & Niemeyer, 2008; Van Maren et al., 2015b). Not only does this increase the tidal wave set up causing higher highwater levels, low water levels at the weir have decreased by 0.6m from 1980 to 2005 (Schuttelaars et al., 2013). The highwater levels are a concern for flood protection (Bos et al., 2012).

2.2.2 Sediment

The tidal asymmetry with longer highwater slack causes a net landward transport of sediment, because the sediment has more time to settle upstream at the turning of the tide. As the tidal amplitude increased, so has the tide-driven sediment flux, increasing landward transport (Van Maren et al., 2015b). The location where transported sediment is trapped depends on the length of the estuary and resonance length of the tidal wave. For estuaries larger than resonance length, the sediment trap is closer to the seaward side of the estuary (Schuttelaars et al., 2013). The Ems-Dollard resonates with its tide, and according to the model of Schuttelaars et al. (2013) the trapping location is therefore probably further upstream than it would have been, had the weir not been positioned at Herbrum.

The amount of sediment in suspension in the Ems-Dollard has dramatically increased over the last decades (figure 3), and the system is now hyper-turbid, especially the Tideems (Van Maren et al., 2015b). The difference between the turbid (muddy) and clearer water is even visible on satellite images (figure 4), the sediment load of the lower Ems is distinctly higher than in the reaches upstream of the weir at Herbrum. Several causes for the high suspended sediment concentration have been identified. Firstly, the reduction of the surface area of the tidal basin leaves less space for the sediment to settle and as supply remains constant, more sediment has to remain in suspension. Secondly, dredging activities for channel deepening and harbour expansion resuspend sediment, contributing further to the suspended concentration, but more importantly, the deepening activities have

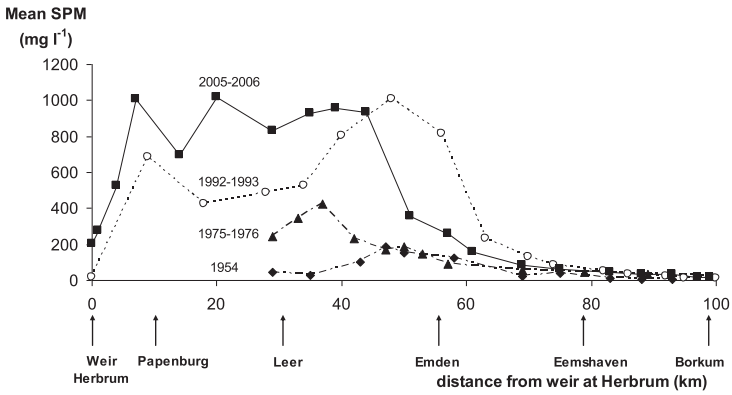

Figure 3 (above): Graph indicates the development of the mean annual suspended matter in the Ems-Dollard since the 1950s. (Source: De Jonge et al., 2014)

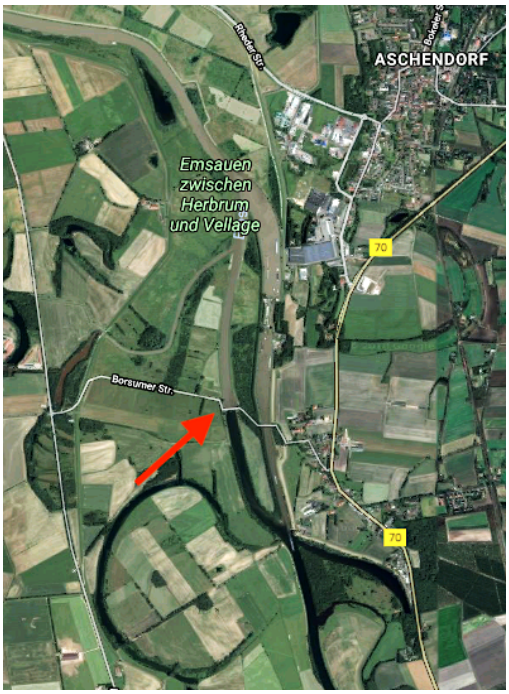

Figure 4 (right): Difference in sediment load north (high and brown coloured) and south (low and black coloured) of the weir at Herbrum (red arrow). North is up. (Source: Google Maps)

influenced the estuarine circulation (Van Maren et al., 2015a). In the Tideems, the dynamics of high suspended sediment concentrations are primarily related to peak flood flow velocities (Winterwerp et al., 2017).

In estuaries, the salinity gradient between salt water inflow from the sea and fresh water inflow from rivers decreases in upstream direction and drives a residual near-bed inland-directed flow in addition to the tide. This is the estuarine circulation and one of the main characteristics that sets estuaries apart from other water systems. The denser saline water from the sea flows upstream along the bed in the direction of the fresh water inflow, that in turn flows at the surface in downstream direction. As the sediment concentration near the bed is higher than in the upper parts of the water column, the salinity-driven flow transports more fine sediment in upstream direction. The estuarine circulation strengthens with increased depth and the deepening activities therefore result in a higher suspended sediment concentration by means of density-driven flow. Van Maren et al. (2015a) have shown that for a deepening of a 10m deep channel by 2-4m, the salinity driven flow strengthens 1.7-2.7 fold. Since the 1950s, the suspended sediment concentration has increased from 10s-100s mg/l to 10s-100s g/l presently (Van Maren et al., 2015a). This is of vital influence on the functioning of the estuarine ecosystem, as biota (primary producers, fish etc) depend on the availability of light (and oxygen) in the water column, that is hampered by suspended sediment (Bos et al., 2012; Taal et al., 2015) (see also section 2.4).

Normally, the maximum suspended sediment concentration or estuarine turbidity maximum (ETM), is located near the fringe of the salt water intrusion (Chernetsky et al., 2010), but the ETM has moved up to 25km in landward direction and the Ems river remains turbid far upstream of the ETM. Suspended sediment itself induces an additional density driven flow that transports sediment beyond the reach of the salinity driven flow (Talke et al., 2009). The ETM has been increasing in surface area since the 1950s and developed into a zone of 30km, that moves up and down the estuary over a distance of 10km (De Jonge et al., 2014). Flow from the Ems river is only able to counteract the incoming sediment flux at high discharges (Van Maren et al., 2015b) and since the early 1990s, the sediment trapping point has moved upstream of the salinity inflection point at the landward side of the salt water intrusion. The tipping point of the sediment balance towards hyper-turbidity (suspended sediment concentration and location of ETM) coincides with channel deepening activities and the changed dredging strategy of Emden harbour in the early 1990s (De Jonge et al., 2014). According to Winterwerp (2013), the transition to hyper-turbidity was a phased response to deepening of the channels in the Ems. Increased upstream transport of sediment enhanced the sediment load in the river, whereafter interactions of the sediment with the tidal hydrodynamics further increase the concentration of suspended particles. When the sediment load reached a critical

concentration, fluid mud formed and the tidal current velocity became the dominant driver of sediment dynamics.

2.3 Water quality

Water quality generally includes not only the chemical content of and suspended substances in the water, but also suspended sediment concentration, oxygen conditions, light and temperature variation (WFD, 2000). As a result from waste disposal of the potato starch industry in the 19th and 20th centuries up to 1990s, large quantities of organic waste polluted the estuary causing anoxic conditions, particularly in the Dollard during autumn. Remediation and sanitation measures have much improved the situation since then (Talke et al., 2009; Bos et al., 2012). Metals, nitrogen and phosphate (nutrient) concentrations are elevated, but lower than in the 20th century. The contribution of other chemicals or "emerging compounds" requires further research.

Oxygen conditions are of particular concern in the Ems-Dollard. Levels have lowered further over the last decades and minimum concentrations in the Tideems have dropped to 0 mg/l in 2000 (Bos et al., 2012). The organic matter attached to the suspended sediment and, importantly, to fluid mud uses up oxygen in the water, causing oxygen depletion in especially the hyper-turbid zone. Other causes such as stratification also contribute to the low oxygen conditions (Talke et al., 2009).

High nutrient levels in the Ems-Dollard are the result of upstream pollution from the extensive agricultural lands in the Ems basin and from coastal currents bringing pollutants in from the Rhine/Meuse delta via the North Sea and Wadden Sea. Phosphate is a major concern in the entire Ems basin, but especially in the Lower Ems. High concentrations of harmful substances (e.g. trifenyltin and PCB028) were found in the Ems-Dollard estuary and pesticides are spread widely throughout the waters in the Ems basin (SGD Eems, 2005, 2015).

2.4 Ecology

Estuarine habitats are importantly characterized by the salinity conditions, that vary from salty to fresh but are mainly brackish, the variety in water depths and flow in the channels, intertidal flats, and supratidal areas. The flora and fauna are tuned to these specific conditions and highly specialized, which makes estuaries much valued ecosystems (Bos et al., 2012; ED2050, 2016). For the flora and fauna to thrive, suitable habitats must be present, water quality must be sufficient, and the food web needs to be functioning. In the Ems-Dollard, all three requirements are under pressure. Herrling & Niemeyer (2015) compared the surface area of the sub-, inter- and supratidal habitats for the Ems-Dollard and Tideems and found that subtidal areas decreased by 34%, intertidal areas by 2% and supratidal areas by 49% in 2005 compared to 1860 for the estuary. For the Tideems downstream from Papenburg the decrease in subtidal areas is 8%, 16% and 13% between 1898 and 2005. What this study did not take into account, however, are the changes within those habitats. For example, subtidal areas include channels that have been deepened substantially and where flow velocities have considerably increased, and this alters the characteristics of the subtidal areas. This subdivision in subtidal, intertidal and supratidal is rather crude and in ecology, habitats are usually defined in a more specific manner.

The EU Habitat Directive (HD) provides a detailed standard for habitat classification that is used for assessing the quality of habitats in protected areas. Above the mean low water line, habitats are mainly moderately moist grasslands, reed lands and pastures for agriculture. Riparian forests are no longer present in the Ems-Dollard system (Bos et al., 2012). Intertidal flats in the German part of the Dollard have been eroding much more rapidly than in the Dutch area, even though most banks and flats in Germany are reinforced (Esselink et al., 2012).

Bos et al. (2012) provide an overview on the ecological state of the fauna in the Ems-Dollard. The basis of the food web is primary production by algae in the water column and microphytobenthos on the flats and where they are stirred, also in the water column. Primary producers depend on nutrient supply (mainly by river inflow) and light conditions. The Ems-Dollard system is hyper-turbid, and primary production is therefore mainly confined to the outer Ems (60% of total estuarine primary production), where conditions are less turbid. Nevertheless, primary production in the outer and middle estuary has halved since the 1970s due to the increasing turbidity and lower oxygen levels

caused by the high suspended sediment concentration (see also section 2.3). Changing the dredging strategy and, for example, disposal of the dredged material in the North Sea instead of locations within the estuary would improve light conditions and thereby increase primary production by 20% (Taal et al., 2015). Even though the fresh water zone can play a large role in primary production in estuaries, the turbidity in the Tideems prevents growth of these micro-organisms (Bos et al., 2012).

Zooplankton directly depends on primary producers, but the state of zooplankton in the Ems-Dollard is unknown. Higher up in the food chain hyperbenthos (small animals living on the bed) is declining in the outer Ems. Seagrass (*Zostera marina*) only colonized the Ems-Dollard from 1973 onwards, reached its maximum extent in 2004, before disappearing almost completely in 2007-2008. Macrobenthos can usually be found in greater numbers towards the seaward side of an estuary, and so it is for the Ems-Dollard. The Tideems, however, has lost much of its benthic diversity since the 1990s due to high turbidity and oxygen depletion. The fish population is in much better shape in the mid- and outer estuary and considered reasonably good. Again, the state of the population in the Tideems has severely deteriorated.

Water quality is a problem for fish in the Ems-Dollard, including local changes in temperature due to cooling water disposal from power plants. Fish encounter difficulties migrating up and down the Ems system because of the physical barriers of weirs and sluices (SGD Eems, 2005), the abrupt changes of salt to fresh water instead of a gradual brackish zone, oxygen depletion and the turbid conditions that inhibit orientation (Bos et al., 2012). The Ems-Dollard is an important foraging and resting site for migratory birds and other bird species (IMP, 2016). The main concerns pertain to the loss of nesting ground to agricultural land, floods in the summer half year because of closing of the Ems barrier (the "Sommerstau") for summer storm surges and for the benefit of the shipyard in Papenburg, and the sediment dynamics and dredging. Larger mammals such as seals and porpoises frequent the Ems-Dollard, but detailed information about their populations is scarce (Bos et al., 2012).

2.5 How to characterize a healthy natural system – the "needs" or "well-being" of the Ems-Dollard?

The Ems-Dollard is an artificially modified natural system. Interference with the natural system goes back centuries and it can be argued that the estuary as it is, would not exist without some sort of anthropogenic influence. Land reclamation and embankments already before 1500 AD have allowed ingressions into the hinterland that enlarged the tidal basin and created the Dollard. Sluices and weirs, primitive or sophisticated, have controlled inflow from the hinterland for centuries. These interventions should not be overlooked, even though major construction works for direct shaping of the river and channel system only commenced in the 19th century. It is therefore difficult to objectively define what a healthy state or "well-being" of the Ems-Dollard would be. The system has been adjusting to find a dynamic equilibrium since the maximum extent of the Dollard was reached in the 16th and 17th centuries, as illustrated by the infilling with sediment that gradually reduced the size of the tidal basin. The major construction works have redirected the system further away from equilibrium, and a tipping point for a strong deterioration of the sediment dynamics and its consequences for the ecological state was reached in the 1990s, when the system became hyper-turbid. The question is now, what a healthy and natural Ems-Dollard would look like or, in other words, what can be considered the system's (natural) reference state (see also box 1). The following characteristics should describe the natural body of the system and its hydromorphodynamic processes and provide the canvas on and within which the biotic ecosystem has its necessary natural habitats. These characteristics also represent the "needs" of the natural system in which legal rights can be rooted.

- The *proportions of the tidal basin* should be in equilibrium with the volumes of inflow from tide and river discharge. What the size would exactly be is not clear, as no dynamic equilibrium state is known from past centuries.
- The *tidal wave* should be able to propagate as a travelling wave and not necessarily resonate as strongly with the estuary. This requires a longer estuary, which is currently prevented by the position of the weir at Herbrum.
- *Open connections with the hinterland* would make drainage from tributaries more natural and would support a more gradual salinity gradient. The salt-fresh water transitions are too abrupt at present. Open connections with the Ems and tributaries are important for the migration of

fish. However, drainage from the hinterland would not automatically improve by the removal of weirs and sluices, because the land behind the dikes has been subsiding, while sedimentation processes that would naturally raise the land surface are inhibited by dikes keeping out sea ingressions.

- The *salinity gradient* from fresh river water to salt sea water is one of the most important characteristics of estuaries in general (Pritchard, D.W., 1967; De Haas et al., 2018). It not only provides unique brackish living conditions for flora and fauna, but importantly, it drives the estuarine circulation by means of density driven flow and regulates sediment transport through the estuary (Chernetsky et al., 2010).
- *Dynamic morphology* of migrating channels, shoals and tidal flats. The estuarine system should rather be a network of channels, with more than the one main channel of the present situation, and where channels are allowed to redirect coarse, aggrade and erode. The main flow can also change its course through a different channel, as it has done in the past, for example when a bend near Emden was cut off in the 16th century and the main flow chose another channel. The people of Emden tried to reclaim the old course of the flow between 1590-1618 using pole structures, but attempts were unsuccessful (RWS, 1966). Erosion of bars and shoals and the growth of new ones maintain the characteristic rejuvenating estuarine habitats (De Haas et al., 2018). A dynamic morphology also entails that the areal extent of the different zones does not remain constant through time. Zones or habitats may be destroyed in one place by waves, flow or erosion and sedimentation processes, while they redevelop in other area. Not all habitats may necessarily be present in the system at any one time.
- *Suspended sediment concentration and ETM*. The current hyper-turbidity is not natural for the estuarine system and the ETM is too extensive and hoovering further upstream than it should be. Before the system tipped into a hyper-turbid state in the 1990s, the ETM was located just upstream of Emden (De Jonge et al., 2014). Schuttelaars et al. (2013) predicted the sediment trap to be near Emden, when the estuary is longer than the resonance length. They used the existing bathymetry between 1980-2005, however, which includes artificially deepened and straightened channels. It is therefore not clear what the natural location of the ETM would be for a natural estuarine morphology. The suspended sediment concentrations should lower naturally when the morphology and body of the system are restored, but concentrations do vary in a natural system when it keeps readjusting itself around its dynamic equilibrium. Moreover, lowering suspended sediment concentrations requires accommodation space for settlement and that is currently lacking in the Ems-Dollard (P. Dankers, pers. comm.). Fluid mud is not a natural phenomenon in this estuary and does not belong in a healthy Ems-Dollard. As long as the fluid mud remains in the system, hydraulic drag will be low and suspended sediment concentrations will be elevated, even if channel dimensions are more natural (Van Maren et al., 2015b). So far, it has not been investigated how this can be resolved.
- *Flow velocities* will adjust accordingly and become lower in case of a natural morphology, tidal wave propagation and bed roughness. The tidal wave set up will decrease, low water levels will increase and (dangerously) high water levels will lower (e.g. Schuttelaars et al., 2013).
- *Water quality* needs amelioration as for the organic and chemical substances in the water. The input of these substances, either through direct disposal, inflow from the sea or carried by drainage of the hinterland, is of great importance for the ecological welfare of the system. However, water quality has no direct connection with the geomorphology, or body of the system, and its hydromorphodynamics except for the turbidity, that is occasionally considered a water quality characteristic (e.g. WFD, 2000).

When the body of the system and its hydromorphodynamics move into the direction of its equilibrium, and water quality is good, the appropriate development of the ecosystem will follow. It is important to stress that the different aspects of a natural system are intricately woven together and that one cannot be changed without influencing the other. The system should therefore be approached as a whole, with all its small scale and large scale processes, feedback mechanisms, upstream-downstream connectivity and back water effects. Furthermore, feedback mechanisms also exist between biotic and abiotic factors in natural systems, for example via the role of eco-engineering species (De Haas et al., 2018) and the effects of vegetation on erodibility of sediments (Kleinhans, 2010; Van Oorschot et al., 2016).

3. Governance of the river basin and estuary

River systems in Europe are often transboundary in nature; rivers cross international borders as they flow from source to sea. Each country is then responsible for the governance and management of a certain stretch of river, an estuary or delta. International cooperation is required because of upstream-downstream connections and backwater effects, because the influence of actions in one part of the system extents to other parts of the system that may lie in a different region or country and thus fall under a different jurisdiction.

In the Ems basin, the river Ems not only flows from one country into another but, importantly, the international border runs straight through the length of the Ems estuary. Management of the estuary is therefore a truly transboundary affair and a shared responsibility between Germany and the Netherlands. Complicating the cooperation in this area, however, is the disagreement on the course of the international border within the estuary up to the 12 nautical mile limit of the territorial waters in the North Sea. The German standpoint in this matter is based on a 16th century letter from emperor Ferdinand I to the Count of Ostfriesland (SGD Eems, 2009), that is possibly forged (Disco & Van Heezik, 2015), stating that the border runs along the low tide line at the Dutch coast and making tidal flats Hond and Paap German territory. In the view of the Netherlands, the border should be indicated following the thalweg (the deepest part of the channel where the main flow runs), as is dictated by international law (SGD Eems, 2009, Disco & Van Heezik, 2015). The Netherlands have made their position clear since the beginning of the 19th century and the recorded dispute on the location of the border has thus been going on for two centuries. As a consequence, there are not two areas of jurisdiction in the estuary, but three: the German territory, the Dutch territory and the disputed area, forming a wedge in the middle of the estuary from Emden to the North Sea (figure 5).

From 1823 to 1896, a series of treaties between the Netherlands and Prussia arranged for responsibilities and obligations regarding the maintenance, navigation matters and payment of costs etc. in the border area (Disco & Van Heezik, 2015). The Treaty of Meppen (1824) settles the D-NL border through the Ems-Dollard "for all time", except for the fact that the stretch of the border towards the Wadden Sea had been forgotten[1]. The German-Dutch border convention (Grensverdrag, 1960) settles matters in the border area, except for where the position of the border is disputed. For the disputed area, the Ems-Dollard treaty was drawn up in 1960, where both countries declare to respect each other's position on the course of the international border and agree to cooperate within this area as "good neighbours". The treaty settles matters regarding navigation and maintenance in a way that can be described as 'agree to disagree' and getting out of each other's hair whenever possible.[2] The Permanent Ems Committee was installed to oversee operations in the Ems-Dollard and for decision-making in case of deviations from the treaty. A supplementary protocol of 1963 concerns exploitation of oil and gas in the disputed area, but only up to a 3 mile zone from the coast, and divides the estuary by a line through the length of the disputed area, for the sake of practicality (Supplementary Agreement Ems-Dollard Treaty 1963). What the Ems-Dollard treaty does not cover, is water quality management and nature conservation. From the 1970s and 1980s, attention was no longer solely focussed on nuisance of poor water quality. Environmental issues started to become more important and the Dollard was designated a "natural monument" in the Netherlands in 1977 and "naturschutzgebiet" in Germany in 1980. A new Ems-Dollard treaty with a double mandate for economic matters as well as environmental issues and nature protection was effectuated in 1984, but

[1] The original Dutch text meticulously describes the course of the border between the Kingdom of the Netherlands and the Kingdom of Hanover from the province Overijssel and county Bentheim up to the Dollard and excluding the middle and outer estuary. "De nieuw bepaalde grenslijn in den Dollard, begint bij het punt, hetwelk op eenen afstand van twee duizend zes honderd vier en zeventig Nederlandsche ellen zes palmen of zeven honderd tien Rijnlandsche roeden, van den aan den voet en noordelijk van den dijk, bij de Statenzijl, thans nog voorhanden paal, naar den Dollard heen, aan den westelijken of linkeroever van den Aa-stroom, te vallen komt, en op de bij dit tractaat behoorende nieuw opgemeten grenskaart, met de letter F is aangewezen. Van hier af, loopt de grenslijn door den Dollard tot aan de Eems, in eenen hoek van acht graden negen en een halve minuten westelijk van de ware noordlijn, welke de middellijn is tusschen het noorden en noorden ten oosten naar het kompas getrokken, overeenkomstig het convenant van den jare duizend zeven honderd drie en twintig voor welk jaar de westelijke afwijking van het ware noorden tot dertien graden zeven en veertig minuten gemeenschappelijk is aangenomen. De hier in den Dollard bepaalde grenslijn zal voor altijd blijven, ofschoon ook de rivier de Aa haren tegenwoordigen loop mogt veranderen." (Treaty of Meppen, 1824, art. 41).

[2] An example of how practical matters are administered in jurisdiction of navigation matters: when a Dutch ship navigates the disputed waters, the water is considered 'Dutch'. When a German ship passes through the exact same stretch of water, the water is considered 'German'. International ships are treated under the law of either of the countries, depending on their destination or harbour of departure (Ems-Dollard Treaty, 1960, art. 32).

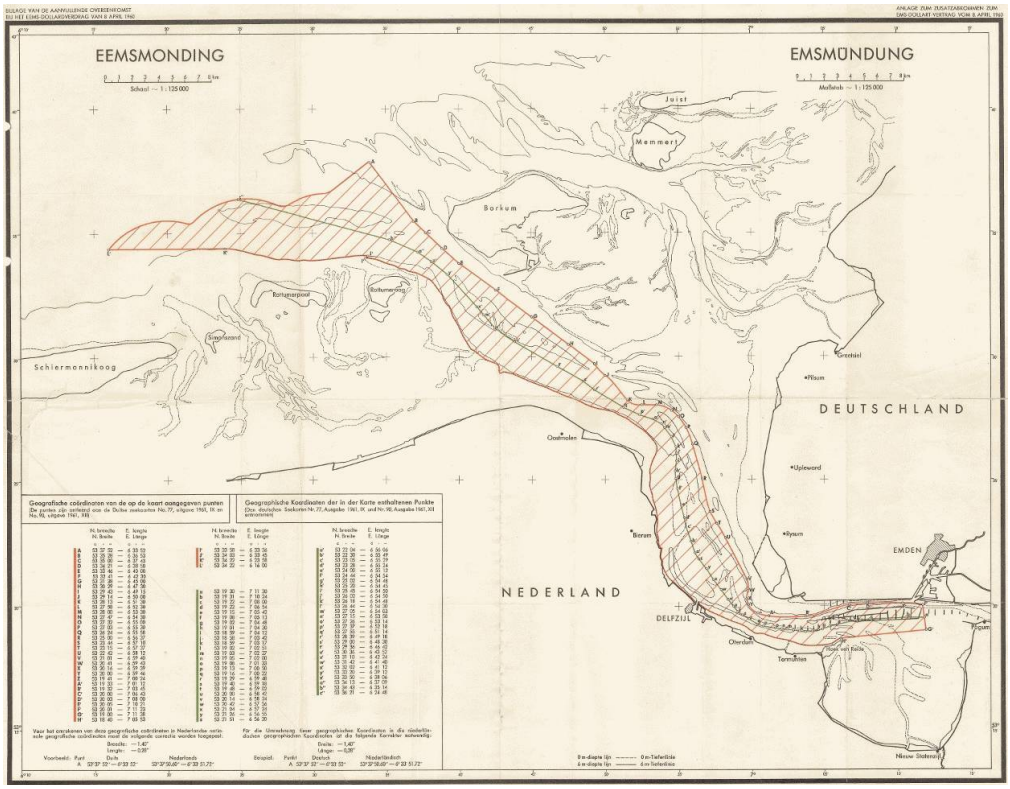

Figure 5: The disputed area (red) in the Ems-Dollard estuary (Source: Ems-Dollard Treaty, 1960)

revoked again only 7 years later, leaving the Ems-Dollard again without an intergovernmental instrument for environment and nature. Opportunities for change came with the 1996 Ems-Dollard environmental protocol and the installation of Subcommittee G under the Border Water Commission, but the intentions for ameliorating the environmental state were not put into effect. It was not until the EU Water Framework Directive and Birds- and Habitats Directives, that environment and nature management really took off in the Ems-Dollard under the pressure of EU legislation (Van Rijswick & Havekes, 2012; Disco & Van Heezik, 2015).

3.1 Implementation of EU directives

Central to the implementation of the EU directives and transboundary cooperation in management of the International River Basin District of the Ems basin, is the River Basin Management Plan (RBMP), that is obligatory under the WFD (box 1), but also takes into account implementation of the HD and BD (box 2). Furthermore, management plans based on the EU Floods Directive (FD, 2007) and the Marine Strategy Framework Directive (MSFD, 2008) are integrated within the RBMP. The former Directive aims to give flood risk management a more prominent position in river basin management, whereas the latter deals with the environmental state of European marine waters. Measures proposed under the WFD should already contribute to alleviating flood impacts, therefore, the WFD and FD are considered synergetic (FD, 2007). The EU directives require the designation of competent authorities responsible for the development of management plans and strategies.

In Germany, the governance structure is based on the principle of subsidiarity, meaning that decisions are directed to a lower authority whenever possible. The German federal government is in charge of all matters regarding navigation, while water management under the WFD and FD is a matter for the states (Länder). The environment ministries (Umweltsministeriums) of the states North Rhine-Westphalia and Lower Saxony are therefore the competent authorities for the German contribution to the RBMP, and they cooperate under Flussgebietgemeinschaft Ems (Ems council and Secretariat Ems). The Dutch ministry of Infrastructure and Environment (currently: ministry of Infrastructure and Water) is the competent authority for the Netherlands. The General Directorate on Planning and Water (RWS) coordinates WFD measures with relevant provincial, municipal and regional water authorities, as well as with drinking water companies.

Box 1: Water Framework Directive

The ratification of the EU Water Framework Directive (2000) marked a milestone in European water management. Preceding EU seminars in 1988 and 1991 had already recognized the ecological quality of water bodies and expressed intentions to prevent long term deterioration of fresh water bodies, but a coherent legal directive was still required. The WFD meets this demand and aims to provide an integrated policy and legal basis for water management in the European community with quality of water bodies as its primary concern. The WFD prominently states that "water is not a commercial product like any other, but rather, a heritage which must be protected, defended and treated as such" (WFD, 2000 section 1).

Water bodies are considered on river basin scale in (International) River Basin Districts, requiring transboundary cooperation among member states and with non-member states. Each (I)RBD is obligated to provide a Management Plan specifying the state of the surface- and ground water in the (I)RBD and measures for improvement in such a way, that all waters should have attained a "good status" by the year 2015. Exceptions are allowed for water bodies that have been severely affected by human activity and for which amelioration is too expensive or not deemed feasible, but further deterioration has to be prevented. According to the WFD, a "good status" consists of good ecological and chemical status, where the chemical status also supports the ecological elements. Hydromorphological conditions in surface waters are only expressed as "elements supporting the biological elements" (Annex V.1, WFD 2000), in the sense that the hydrological regime and morphology need to be in such shape, that the biota that would be naturally occurring in a water body have a suitable habitat. The relevant quality elements for the classification status of the WFD are provided in table 1. The status is considered good if there are only slight deviations from the natural conditions without anthropogenic influence.

For each (I)RBD a reference state needs to be determined, representing (relatively) undisturbed conditions without anthropogenic influence. From that reference state, a quantitative "good status" is derived (Stowa, 2012). For example, the areal extent of mudflats in the Dutch Ems-Dollard estuary is defined as 7.5% of the total tidal area, which is equivalent to 700ha. As reference state, however, the 1950s-1960s are assumed because a fully natural state is deemed unfeasible, considering the drastic artificial hydromorphological changes (Wielakker et al., 2011). The consequences for not complying with the aims set by the WFD are not directly clear. There is only mention of the polluter-pays principle and that the member states need to determine proportional, effective and dissuasive penalties in case of breach of the Directive. However, European Law warrants that non-compliance with EU directives leads to a sentence that may include (financial) penalties (WFD, 2000).

Table 1: Quality elements for the classification of ecological status for the WFD (WFD, 2000)

	Rivers		**Transitional waters**	
Hydromorphological elements supporting biological elements	Hydrological regime	Quantity and dynamics of flow	Morphological conditions	Depth variation
		Connection to groundwater bodies		Quantity, structure and substrate of the bed
	River continuity			Structure of the intertidal zone
	Morphological conditions	River depth and with variation	Tidal regime	Freshwater flow
		Structure and substrate of the river bed		Wave exposure
		Structure of the riparian zone		
(Physico-) chemical elements supporting biological elements	Thermal conditions		Oxygenation conditions	
	Oxygenation conditions		Thermal conditions	
	Salinity		Salinity	
	Acidification status		Transparency	
	Nutrient conditions		Nutrient conditions	

Box 2: Habitats and Birds Directives

For protection of valuable species and habitats in the European Union, the Natura2000 network has been established and expanding since 1992. Natura2000 sites are designated based on the Habitat- and/or Birds Directives as Sites of Community Importance (SCIs), Special Areas of Conservation (SACs) (both under HD), or Special Protection Areas (SPAs) (under BD). The importance of these directives for the governance of natural systems, is that protection of species is mainly carried out through the protection of habitats in which endangered, vulnerable, rare or endemic species reside during either of the phases of their lives (HD, 1992; BD, 2009). The abiotic conditions in those habitats therefore need to be in sufficient or good ecological condition. If required for the protection of species, elements in the landscape may also be constructed and developed by means of human intervention to ensure that primary needs of the wild flora and fauna are met (HD, 1992; BD, 2009). Conservation goals need to be formulated for each N2000 site, they can be "preservation", "expansion" or "amelioration" of either surface area or quality. In any case, deterioration is to be prevented but goes without consequences if the deterioration is caused by external forcing agents such as climate change. This means that the area of certain habitats such as intertidal flats is not allowed to decrease, while it is also mentioned that the flats are part of a dynamic system that is prone to erosion and sedimentation processes and thus vary in extent (Ministry LNV, 2008). In case of reasons of overriding public interest, projects that cause significant harm to the protected nature may still proceed, and compensation measure are required to warrant the overall coherence of N2000 (HD, art. 5).

The IRBD Ems is subdivided into three coordination areas: Ems North, Ems South (both under German responsibility) and Ems NL (Netherlands). International cooperation for the river basin is spread over a multilevel system with the Steering Group Ems on the first level, the Coordination Group Ems for operational matters on the second level, and on working level, seven sub-basin districts execute concrete measures. Relevant for the Ems-Dollard are sub-basin district Lower Ems (under responsibility of the Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz, NLWKN, the nature and environment office of Lower Saxony) and the Ems-Dollard estuary, that is under the responsibility of Subcommittee G of the Border Water Commission (working group 'water quality') because it includes the disputed area (SGD Eems, 2015).

Before publication of the first RBMP in 2009 (SGD Eems, 2009), the state of the waters within IRBD Ems for the WFD was reported in 2005. The Lower Ems and the Ems-Dollard estuary cover 3911 km^2 and are home to 65 distinct water bodies. The water bodies are classified for the WFD and Dutch classification typology is matched with the German equivalent. Quality assessments are limited because of a lack of specific reference characteristics. German measuring methods for biological water quality are based on the saprobie-index (amount and intensity of degradation of organic matter), that is translated to the WFD status classification. The Ems between Herbrum and tributary Leda near Leer is classified as heavily polluted, and further downstream the waters are classified as critically affected, which means that the Ems-Dollard system does not meet the criteria for a "good status" under the WFD. The hydromorphological adjustments and regulation of water flow are principally considered in the light of migration of aquatic organisms and not so much in relation to the effects on the tide, estuarine circulation and sediment transport and deposition processes (SGD Eems, 2005). The WFD also requires an outline on economical components in the river basin. Agriculture and economic activities in harbours and navigation, as well as gas extraction in the Netherlands were at the time expected to increase compared to the 2005 state of the IRBD.

The RBMP for the Ems basin was drawn up to inform the European Commission and the public about the progress on implementing the WFD and also serves as a legally binding document for the national governments of the Netherlands and Germany. The first RBMP concerns the period 2010-2015 (SGD Eems, 2009) followed by the second RBMP for 2016-2021 (SGD Eems, 2015). The parties involved have expressed that cooperation is based on mutual trust (SGD Eems 2009, p.4). In the RBMP 2009, realisation of the goals of the WFD for a good ecological and chemical status[3] for the Lower Ems and ED-estuary were deemed highly unlikely or unclear within the set period to 2015. Nevertheless,

[3] In addition to a good ecological and chemical status (or in the case of heavily modified water bodies, a good ecological potential), the aims of the WFD as formulated for the surface waters in the Ems basin are: deterioration is prohibited; decrease of pollution with priority substances; phasing-out of discharge, emission and loss of priority dangerous substances (SGD, 2009, p. 67)

no exceptions are invoked yet for more flexibility of the environmental goals, even though they are allowed under the WFD for heavily modified water bodies. Furthermore, the consequences for re-naturalisation of the water system are considered to be in major conflict with economic activities and interests of society.[4] Therefore, compensation measures for nature protection are part of the so called "responsible solution".

An extra management cycle was deemed necessary and extension of the period was appealed for under the WFD (SGD Eems, 2013). Thus, a new RBMP was drawn up for the period 2015-2021 reaffirming that a good ecological and chemical status in the Ems-Dollard area was not achieved by 2015, mainly due to hydromorphological bottlenecks and high nutrient concentrations. New insights and research during the first management cycle made clear that a good status is unlikely to be achieved by 2021, except for the chemical status of 5 small rivers in region Ems NL (SGD Eems, 2015). Only 7 of the 149 water bodies in the Ems North and Ems NL regions of the basin are classified as natural, of which 4 are coastal waters and none are rivers and canals, all others are heavily modified or artificial. The aim for these waters is to strive towards the "highest ecological potential" (SGD Eems, 2009). Similar to the WFD, the "MEP and Ecological Rules method" used for classification only infers hydromorphological (and fysico-chemical) elements from the biological conditions, but these elements are not evaluated in their own right (Stowa, 2012). Participation and involving the public is an important component of the RBMP, several consultative bodies have been created in which authorities and interest groups on different levels work together to put the WFD into effect (SGD Eems, 2015).

3.2 Meanwhile in the Ems-Dollard region

While the RBMP arranges the basin-wide coordination and implementation of the WFD for achieving better ecological and chemical status of the water bodies, several other initiatives developed simultaneously to achieve similar goals and/or implement the WFD and the HBDs at a regional level. In the Netherlands, the Ems-Dollard was designated under the N2000 network in steps, starting with the initial registration of the Dollard at the European Commission in 2003. The Ems-Dollard was added to the Wadden Sea N2000 area in 2008, but designation under the Habitat Directive was delayed until 2017 due to legal proceedings in Germany (Ministry LNV, 2008; Ministry EZ, 2017). The Ems-Dollard is therefore taken into account in the Program towards a Rich Wadden Sea (PRW) (Ministry I&M, province Groningen, 2015). Although N2000 areas form a network across the countries, management is a regional affair and relegated to competent authorities NLWKN of Lower Saxony and the province of Groningen in the Netherlands.

The notion that the poor state of the Ems-Dollard needs to be addressed has gotten response from authorities, NGOs and other stake-holders in the region and they started to cooperate in 2009 under the project E&E Ecology and Economy in balance, an initiative of province Groningen. All parties involved in the Declaration of Intent (2012) and the Agreement of Cooperation (2014)[5] recognize the importance of ecological restoration, agree that the deterioration in the region is a consequence of human actions, and set targets for restoration of the ecosystem, especially addressing turbidity, and the accessibility of the Eems Harbour, all to be accomplished by 2030. According to the agreement, its "legitimacy" is arranged when the parties implement it in their own organizations. Cooperation with German counterparts is deemed essential, but they are not involved in E&E (E&E 2014).

International cooperation between Germany and the Netherlands is arranged in the Integral Management Plan (IMP), drawn up by the competent authorities for the regional implementation of the RBMP and Natura2000. Such a policy document is common practice in Germany and involves deliberation with and professional contributions of other parties besides the authorities at different levels, in particular NGOs and economic stake-holders. The main aims for the Ems-Dollard formulated

[4] "the development of flood plains characteristic to water bodies is not possible without disproportionately strong consequences for other equally important sustainable activities for human development (…) undoing large hydromorphological enlargement measures on a large scale (…) would lead to lasting loss of agricultural land and deterioration of the accessibility of agricultural and forestry areas" (SGD 2009, p. 21)

[5] The parties signing the Declaration of Intent (2012) and Agreement of Cooperation (2014) are province Groningen, ministry of Infrastructure & Environment, ministry of Economic Affairs, Groningen Sea Ports, Cooperating Companies Eemsdelta, Nature & Environment Federation Groningen, Coalition Wadden Natuurlijk (representing NGOs), with partners municipalities, water boards and LTO Noord (agricultural association) (E&E, 2012; E&E, 2014).

in the IMP are restoration and improvement of the hydromorphological integrity, estuarine connections and basis of the food web. The IMP itself is not legally binding, but serves as a specialist grounding for management that is effectuated in each country in documents that do provide a legal basis, the MIRT-report (NL) and Masterplan Ems 2050 (D) (IMP, 2016).

The MIRT-report (multiannual investment program for infrastructure, spatial planning and transport, customary in Dutch policy) is the culmination of a series of studies commissioned by the Dutch government. It is conducted for and in cooperation with the E&E platform, to map out problems and opportunities in the Ems-Dollard under the umbrella of the Program Eems-Dollard 2050 (Ministry I&M, 2015). The aim for 2050 is "a coherent estuary with appropriate dimensions, with healthy habitats, with natural transition zones and sufficient food at the basis" (Ministry I&M, 2015, p.1). A suite of measures has been proposed and some are in the pilot-phase, already in progress or finished, coordinated under the multi-annual adaptive program (ED2050, 2016).[6]

The German Masterplan Ems2050 is the result of cooperation between regional authorities, NGOs and economic stakeholders[7] and is the legally binding agreement on implementation of the EU directives and IMP. However, the focus in the Masterplan lies more on economics, "to align the ecological and economic interests, that are recognized as equivalent" (Masterplan Ems 2050, 2015, preamble). The aim of the Masterplan is "sustainable development and optimization of the Ems estuary in view of naturalness, safety and accessibility" (Masterplan Ems 2050, 2015, art. 4.4). Priorities are the turbidity problems, improving the state of the Tideems waters and estuarine habitats, protection of avifauna and their habitats and maintaining the waterway function of the Ems for businesses and harbours. Development of measures is designated to steering groups and working groups and cooperation with the Dutch Eems region is required in "good neighbourship" (Masterplan Ems 2050, 2015). Aims for improving and the importance of hydromorphological integrity as formulated in the IMP and MIRT were not adopted in the Masterplan.

At present, several pilot studies are undertaken in the Ems-Dollard to test the effectiveness of proposed measures and to see if restoration measures are feasible (P. Dankers, pers. comm.).

3.3 The web of say and interests: a discussion

Managing the Ems-Dollard is a complex affair spread over multiple administrative layers in two countries, a transnational authority overseeing the disputed area, and the participation of public and private parties in the form of nature conservation associations and economic stake-holders. Now, the question is how this web of say and interests is functioning and whether it is succeeding in moving towards a naturally balanced riverine and estuarine system. There are essentially three pillars to be discussed. First, at a practical level, this is the coordination, cooperation and implementation of nature and water policy in and between Germany and the Netherlands. Next is the question whether policy as it stands is effective in encouraging and enforcing its aims, and finally, to what extent other interests are influencing nature and water policy in the Ems-Dollard system.

International cooperation between Germany and the Netherlands in the Ems-Dollard region has a long and complicated history because of the disputed border area. Furthermore, the different administrative structures in both countries do not always pair well in terms of competences. The functioning of German national waterways and navigation is arranged at federal level by the Wasserstraßen- und Schifffahrtsverwaltung des Bundes (WSV), while water quality and nature are the responsibility of the states. International cooperation with the Netherlands, where all are under federal ministries and usually represented by RWS, thus occurs with German federal representatives when it comes to navigation and the use of waterways, and with state representatives on water quality (Disco & Van Heezik, 2015). The many different commissions, committees and steering groups, each having representatives from different administrative levels, add further to the complicated management structure. The linguistic boundary has proven to be difficult and time consuming when it comes to translation of all documents (IMP, 2016) and bureaucratic procedures in Germany are

[6] The Multi-annual adaptive program coordinates measures in three tracks: Executive program Vital Coast (ED2050, 2017a), Innovation program Useful Application of Mud (ED2050, 2017b), Plan of Action Hydromorphological Improvement (ED2050, 2017c).

[7] The agreement and Declaration of Intent of the German Masterplan Ems 2050 are between the state Lower Saxony, Federal government, district Emsland, district Leer, city of Emden, nature conservation federations WWF, BUND and NABU and shipyard Meyer Werft GmbH in Papenburg (Masterplan Ems 2050, 2015).

considered cumbersome and delaying implementation of measures (Disco & Van Heezik, 2015). On the contrary to the Netherlands, the competent authorities in Germany (states) do not always act as the executive authorities. The Landkreise (districts), 'Unterhaltungsverbände', 'Wasser- und Bodenverbände', for example, receive funds from the states to stimulate practical implementation of the RBMP, but lack of support and means hampers putting the measures into effect. A lack of funding is a major hindering issue in the Netherlands, as national budgets for nature protection and management were cut and nature restoration projects have therefore become uncertain (SGD Eems, 2015).

After the management period of the first RBMP, it was found that the fact that the RBMP does not have legal consequences for third parties is hampering implementation of the measures (SGD Eems, 2015). At EU level, the WFD obligates member states to determine penalties for breaching the regulations that each country develops to implement the WFD. The difficulties with shared responsibilities within transboundary river basins as to a lack of legal accountability for the river basin as a whole is a known problem in EU water law. Therefore, water management remains relying upon the cooperation of the (member) states within the river basin (Van Rijswick et al., 2010). Nevertheless, EU directives did provide the necessary incentive for Germany and the Netherlands to seriously start to take action and cooperate internationally when it comes to water quality and nature in the Ems-Dollard region (Disco & Van Heezik, 2015). The RBMPs and IMP are tangible results of this cooperation, but deliberation with stake-holders and interest groups for the IMP takes place in each country separately, in the country's own language. Refining policy is also occurring in both countries separately, in the Masterplan and MIRT, although they do both express the need for international cooperation.

The difference in focus and priorities becomes apparent when comparing the German Masterplan and the Dutch MIRT, for example illustrated by the lack of hydromorphological re-naturalisation measures in the Masterplan. Emphasis in the MIRT lies more on developing ways to reach the "ecological target state", while the Masterplan is rather a formal document with more room for economic interests. Both the Dutch E&E platform and German Masterplan, and the international IMP involve public and private parties and stake-holders already from an early stage. This should improve the support for restoration projects, which is especially desirable if measures touch on socioeconomic or other anthropogenic activities. The IMP allows all parties involved[8] to comment on the proposed measures. It was noted that the parties in the Dutch deliberation rounds searched for synergies and mutual interests, while German deliberation rounds with similar stake-holders were characterized by a focus on business and conflicts, mainly between economic interests and nature conservation.

German economic stake-holders have expressed their doubts on the use of and need for Natura2000 and consistently point out potential conflicts with proposed restoration measures. Some because of uncertainty about the effects on navigation and economic activities, but at times also when there does not seem to be any relation with these activities at all, for example in a project for the removal of bank reinforcement materials in a National Park (IMP, 2016, p.69).

The IMP explicitly does not weigh the interests of nature versus economy, but the Masterplan and MIRT do and are legally binding. The Masterplan holds assurances for those using the Ems for navigation, and especially for the shipyard in Papenburg. The importance of the shipyard is acknowledged and the location in Papenburg is warranted. Furthermore, NGOs have committed to not make any appeals against the extension of the winter operational period of the Ems storm surge barrier and it is stated that "proposed measures may not adversely affect the functioning of the national waterway Ems, nor hinder ship conveyances of Meyer shipyard" (Masterplan Ems 2050, 2015, attachment e to art. 13). In the Dutch E&E agreement, the previously decided further deepening of the channel towards Eemshaven is warranted because the harbour already expanded in anticipation of the deepening. NGOs agree to be reserved in taking legal action against deepening activities, provided that MIRT measures offer enough prospects for the recovery of the system (E&E, 2014). With signing this agreement, the Dutch NGOs also demanded that serious efforts for nature restoration would finally be undertaken, and that has been agreed to by the authorities and other parties (W. Iedema, pers. comm.).

[8] Professional contributions to the IMP are from parties, interest groups and stake-holders in the following fields: Natura2000; spatial planning; WFD; High water management and coastal protection; navigation and sea ports; agriculture, fishery and hunting; economic business; recreation and tourism (IMP, 2016).

4. Legal rights for river systems

From the above, it becomes clear that the ecological and hydromorphological problems in the natural riverine and estuarine system of the Ems-Dollard are severe and that a cooperative approach to attempt to resolve these problems has taken shape under the Water Framework Directive since 2000. However, it is also evident that plans and measures to ameliorate the state of the Ems-Dollard system are in conflict with the interests of economic activities in the region and that the economic argument weighs heavily in the balance versus nature. In recent years, initiatives have started to develop in countries all over the world to grant natural entities or systems the rights of a person and give them a stronger legal position towards other (conflicting) interests. Would granting rights to river systems, custodianship, and/or legal personhood serve the aim of reaching a naturally sound and sustainable Ems-Dollard system? And would it be a solution or valuable addition to the management of the river basin or would it be just another layer in the already complicated web of policy? There is also the matter of deciding what exactly is in the best interest of the natural entity. What is or should be its state of wellbeing and how does this relate to human activities within or in relation to this natural entity? The third part of this report aims to shed light on these questions and ends with an integrated discussion on the findings of this research and a more normative essay than is common in the natural sciences, on the matter of the importance of the naturalness of a natural system.

4.1 Rights of nature – an introduction to the story so far

The discussion on granting rights to nature and natural entities followed from rapid developments in environmental law since the 1960s (O'Donnell & Talbot-Jones, 2018) and took its first steps in the concepts proposed by American environmental jurist Stone (1972). He argued from a viewpoint of Common law, that natural "things" should have the right to have standing in court when harm is inflicted upon them. As the American legal system requires the status of a legal person in order to be allowed to stand in court, here was no voice to speak on behalf of the natural entity when that entity suffers from decisions and actions by human beings, for example construction works in nature reserves or pollution. Although the impact of Stone's concepts on environmental law have long remained limited (Naffine, 2012; O'Donnell & Talbot-Jones 2018), recent instances of rights to nature and legal personhood have made his concepts relevant, especially for countries with Common law systems (see section 4.2).

Stone, in his updated essay of 2010, argues that granting rights to anything is an action of human beings (men) deciding what is important enough to be of equal enough standing to face them in court, e.g. women, slaves, aliens etc. Holding rights should then at least entail the following: the entity can "institute legal actions at its behest"; harm to the entity must be taken into account standing in the court of law; relief granted by judicial decisions must "run to the benefit" of the entity (Stone, 2010, p.4). Harm to the entity is considered an important part of granting rights or legal personhood, if the aim is to solve environmental problems. This is where the concepts proposed by Stone (1972) has influenced models on environmental law (O'Donnell & Talbot-Jones, 2018).

4.1.1 Legal personhood

If granting rights to natural systems takes the form of legal personhood, as was done for the Whanganui river, for example (Te Awa Tupua Act, 2017), this brings with it a suite of questions, reflections and objections. First and foremost, the definition of being a legal person. An important act of Law is to divide between a legal person (a being that can act in law) and a legal non-person (who cannot act in law and is usually considered property) (Naffine, 2003, p.347). In between there is the dual status of a corporation, that can act as a person and can also be considered property. Corporations, however, lack a "moral status" and are therefore more a legal abstraction, although the debate about the supposed difference between a legal and a moral person is extensive (Naffine, 2003).

There are basically three ways in which legal personhood can be interpreted, as distinguished by Naffine (2003). The first is purely technical as far as the law is concerned. It serves its purpose in legal matters but does not entail any metaphysical concept of being a (human) person. The second way has its basis in a concept of "humanity" and is connected to being a "creature of nature". The third view on legal personhood considers a "moral agent" or certain cognitive capacities necessary for being a

person. In reality, legal personhood will lie somewhere between these three views, as all have their limitations. For example, if responsibility and intelligence would be a prerequisite for being a person in the third interpretation, not all human being would qualify as such because they either do not meet the criteria or are incapable. For example, a comatose human is a legal person with rights but is unable to advocate this for him or herself (Naffine, 2003). O'Donnell & Talbot-Jones (2017, 2018) argue that the legal rights of natural entities are more restraint than those of a human being, and limited to "legal standing, the right to enter and enforce legal contract and the right to own property" and that the question of rights for nature is about "having rights" as opposed to "having rules about something".

Granting legal personhood to nature would in principle be a matter of law and the practicality of protecting nature. As a legal person should capture the essence of the personal being, a natural entity as a legal person should also be defined by its "nature or quality of life" if it is personified for law (Naffine, 2012). That said, it is not about awarding "personal" qualities or characteristics to a natural system or entity, but about acknowledging its existence and those properties and processes that make it the natural or living system that it is. With that, the natural object or system (e.g. mountain, river system) needs to be recognized as an "entity", or a distinguishable unit, to make a legal person of.

4.1.2 Custodianship

When legal persons are unable to speak for themselves or exercise their rights, a custodian can do that for them. A natural entity with rights would be represented by a guardian or custodian that represents the voice of the "needs" of the natural entity. Stone sees custodianship as a possibility for common areas, such as oceans, where the oceans would be regarded a more or less sovereign state in the court of law. Such a custodian should then "monitor the health of the oceans (…) monitor compliance with applicable laws and treaties (…) exercise a legislative advisory function" (Stone, 2010, p.101). The success of a custodian or guardian would improve if it was supported by conventions that set protective standards for pollutants, for example (Stone, 2010).

It would also be possible to assign a custodian to a natural system or natural entity to advocate its interests, "will" and "wellbeing", without the status of legal personhood. However, without the support of legal rights it would be just another voice at the table and there are already institutions that operate and care for the environment. As Stone (2010) also pointed out, the custodian would run the risk of being metaphoric and symbolical.

Furthermore, legal personhood brings along the principle of liability. If a natural entity is found to be the cause of injury to another party (e.g. humans), how would compensation be arranged, since natural entities have no means to pay for damages, for example. And how would one determine liability for a natural event? Which part of a system or external forcing is the actual cause of a destructive event such as a flood, is it the river system itself, the water flowing through it, or the source that sent the water through the system in the first place (e.g. glacier, rainfall event)? (Stone, 2010). A solution would be a restricted form of legal personhood for natural entities, that excludes liability.

4.1.3 Rights of nature

More general than granting legal personhood or appointing a custodian is plainly acknowledging the rights of nature and thereby providing a basis for legislation on rights of nature. The general view towards rights of nature has been evolving over the past decades. The UN already officially stated in 1982 that "Nature shall be respected and its essential processes shall not be impaired" (UN World Charter for Nature, 1982, 1.1) and that the proper functioning of a natural system should always be taken into account in decision-making, planning and other activities of humans. However, the charter also states that irreversible damage should be avoided and that benefits should outweigh expected significant risks to nature. The view towards nature expressed in the charter can be considered anthropocentric.

Since 2009, "Harmony with Nature" became a recurring issue under the sustainable development theme of the UN, with yearly reports expressing the view of the UN on the matter and providing recommendations for the member states (e.g. UN, 2010).[9] A holistic approach towards

[9] The UN states that "The present technological age has seen an impoverishment in the historical relationship between human beings and nature. Nature has been treated as a commodity that exists largely for the benefit of people, and all environmental problems as solvable with a technological fix. Loss of biodiversity, desertification, climate change and the disruption of a number of natural cycles are among the costs of our disregard for nature and the integrity of its ecosystems and life-supporting processes. As recent scientific work suggests, a number of planetary boundaries are being transgressed and others risk being so in a business-as-usual world" (UN, 2010a, art. 101).

sustainable living was proposed, including cross-disciplinary research and widespread education on environment that goes beyond nature conservation, (UN, 2010). The IUCN, that is an official observer and consultant for the UN (UN, 2016), issued the "Universal Declaration of the Rights of Mother Earth"[10] in 2010.

The reports on "Harmony with Nature" illustrate the changing view from nature as a resource to the intrinsic value of nature. While the charter was somewhat precautious about putting forward the importance of nature in relation to economic development, the Third report on Harmony with Nature (2012) distinctly states that humans need to develop a "profound respect for the Earth and an acknowledgement of the vital imperative that the planet continue to exist and thrive" (UN, 2012, art. 3). Furthermore, education about the Earth is considered of vital importance, but has been mainly focused on resources instead of the intrinsic value of nature. A transition from a human-centred to an Earth-centred view was proposed in 2016 (UN, 2016) and this has started to take root in many projects, discussions and policy strategies around the world (UN, 2018).

4.2 Examples of custodianship, rights of nature and legal personhood

There are only a few instances worldwide where rivers or nature as a whole have been granted legal rights. The most prominent, and the only case where a river system was granted legal personhood, is the Whanganui river in New Zealand (Te Awa Tupua Act, 2017). The Yarra river and lands in Australia have been assigned a custodian (Yarra River Protection Act, 2017) and in Ecuador (Constitution of the Republic of Ecuador, 2008) and Bolivia (Ley de Derechos de la Madre Tierra, 2010) the rights of nature are anchored in national legislation. Furthermore, court rulings on the rights of river system concern the Ganga and Yamuna river systems in India (Uttarakhand High Court ruling, 2017) and the Atrato river in Colombia (Atrato river ruling, 2016). In Europe, there have been no cases of legal personhood or rights of nature thus far.

Legal systems as well as the definition of a legal person differ around the world (Cano Pecharroman, 2018) and therefore, the aforementioned instances are not necessarily transposable to western Europe. The legal systems of Commonwealth countries are based on Common Law, while those of South American countries as well as mainland Europe are rooted in forms of Civil Law. The difference is slightly intangible, but in general, Common Law sets more value on jurisprudence and being a legal person if one is to stand in court, while Civil Law adheres more to written law (H.K. Gilissen, pers. comm.). Nevertheless, it is interesting to see how the different examples of granting legal rights to river systems are arranged and functioning.

4.2.1 Whanganui river, New Zealand

In 2017, the Whanganui river including its tributaries and river bed was designated as a legal person, Te Awa Tupua, following a long-pursued desire from the Maori for amends of what has been taken from them since the settlement of colonists in 1840. The Te Awa Tupua Act (2017) not only comprises legal personhood and arrangements for a custodian, it firmly apologises for the wrongdoing of taking land from the native peoples (iwi) and for the harm the iwi have experienced from the disturbance of their connection with nature. The grounds of recognizing the Whanganui river as a legal person are that Te Awa Tupua is "an indivisible and living whole, comprising the Whanganui River from the mountains to the sea, incorporating its tributaries and all its physical and metaphysical elements" (art. 69.1) and that the iwi and the River are intrinsically connected, the River being an important source of physical and spiritual sustenance: "*E rere kau mai te Awa nui, mai i te Kāhui Maunga ki Tangaroa. Ko au te awa, ko te awa ko au*" ("The Great River flows from the mountains to the sea. I am the River and the River is me") (art. 70.b). This encompasses the essence (Tupua Te Kawa) of Te Awa Tupua. The connection with the iwi may well be (one of the) foundations of Te Awa Tupua's status as a legal entity, if legal personhood is regarded in the sense of a corporation (the river) and the human individuals in that corporation give the river a status similar to a corporate personality (Hutchinson, 2014).

[10] The Universal Declaration of the Rights of Mother Earth states that "we are all part of Mother Earth, an indivisible, living community of interrelated, interdependent beings with a common destiny" and that "it is not possible to recognize only the rights of human beings without causing an imbalance within Mother Earth".

The custodian with full capacity is Te Pou Tupua, that is to act and speak for Te Awa Tupua in order to "promote and protect its health and wellbeing" (Te Awa Tupua Act, 2017, art. 19.1). Furthermore, an advisory group, strategy group and commission are arranged for, as well as the development of a River Strategy, Te Heke Ngahuru. The strategy group is in charge of the River Strategy, and its members are appointed by all parties that have an interest in the Whanganui river.[11] The government has installed a fund that pays for all costs for the sake of the health and wellbeing of Te Awa Tupua. A very important part of the Act is a transfer of ownership of the river grounds. The Crown, as it is stated (New Zealand is still under the constitutional monarchy of the English Queen), cedes the territory occupied by the river entity in the transfer of rights to ownership by the river itself. Should the river change its course by natural processes, this territory will return to the Crown. Privately owned river grounds remain property of the private parties (Te Awa Tupua Act, 2017), and the transfer of rights of ownership is therefore incomplete. It is not clear how the rights of the private owners compare to the rights of the river (Hutchinson, 2014).

4.2.2 Yarra river, Australia

In Australia, the Yarra River Protection Act (2017) considers the Yarra river "one living and integrated natural entity" (art. 1.1) aiming to keep the river "alive and healthy for future generations" (preamble). Similar to the Whanganui case, the strong connection of the native people with their natural surroundings is acknowledged and they are recognised as custodians of the Yarra waters and lands, that they refer to as Birrarung. However, there is not a transfer of rights or ownership towards the natural entity Yarra, as was done for Te Awa Tupua. The Yarra River Lands remain under the Crown and the government of the state Victoria is the competent authority. The Yarra River Lands not only encompass the river, but also the surrounding lands. Where the Yarra flows in urban area (e.g. through the city of Melbourne), the urban natural entity is referred to as the Greater Yarra Urban Parklands.

The Act aims to promote and advance the health of the riverine environment and arranges for the development of a Strategic Plan as guidance for future use and development, the designation of protection areas and a long term (>50jr) vision. A commissioner is to report on progress and implementation. While the native people are recognized as custodians, actual custodianship is established in the Birrarung Council, in which representatives of the native people, environment agencies, agriculture and local community take seat. Additionally, "skills-based" representatives are required, that are competent in any of the specified fields.[12] Furthermore, any decision-making may not be in conflict with the Yarra protection principles and the Yarra Strategic Plan, this includes actions of the harbour management, the water corporation and spatial planning.

4.2.3 Rights of Nature, South America

The rights of nature as a whole have been established in the Constitution of Ecuador (2008) and national legislation of Bolivia (2010). Both countries regard nature, Pacha Mama (Ecuador)[13] or Madre Tierra (Bolivia)[14], as a living system including all its biotic and abiotic components, its cycles and processes. This living system is to be respected and protected, human activities should operate in harmony with nature, and nature has the right to be restored (Constitution of the Republic of Ecuador, 2008; Ley de Derechos de la Madre Tierra, 2010). Bolivia further specifies the rights of nature (rights to life, the diversity of life, water, clean air, equilibrium, restoration, pollution-free living) and emphasises the interaction and connection of humans with nature (e.g. art. 4).

Both Acts deal with the fundamentals of granting rights and not the practical matters or specifics of nature conservation and protection, but each does establish an office in its legislation. Ecuador arranges State Guardianship over the environment in a decentralized national environmental

[11] Part of the strategy group are representatives of "iwi, relevant local authorities, departments of State, commercial and recreational users, environmental groups" (Te Awa Tupua Act, 2017, art. 29.2)

[12] The government appoints a skills-based member of the council with expertise or skills in either: waterway health, aquatic ecology, urban design, landscape architecture, urban parks and recreation, statutory planning, environmental planning, public participation processes, community health (Yarra River Protection Act, 2017, art. 49.2)

[13] Ecuador: "Nature, or Pacha Mama, where life is reproduced and occurs, has the right to integral respect for its existence and for the maintenance and regeneration of its life cycles, structure, functions, and evolutionary processes" (Constitution of the Republic of Ecuador, 2008, art. 71).

[14] Bolivia: "Mother Earth is a dynamic living system comprising an indivisible community of all living systems and living organisms, interrelated, interdependent and complementary, which share a common destiny. Mother Earth is considered sacred, from the worldviews of nations and peasant indigenous peoples" (Ley de Derechos de la Madre Tierra, 2010, art. 3).

management system and sees conservation as a joint responsibility of citizens (Constitution of the Republic of Ecuador, 2008). Bolivia established the Office of Mother Earth in defence of the rights of nature (Ley de Derechos de la Madre Tierra, 2010). The benefit of embedding rights of nature in a constitution, is that cumbersome procedures of standing and pleading formalities are circumvented and thus making it easier to protect nature on the basis of its naturalness (Daly, 2012). However, the force and effect of this legislation granting rights to nature as a whole has thus far remained limited (Boyd, 2017; O'Donnell & Talbot-Jones, 2018).

4.2.4 Atrato river, Colombia

In Colombia, a ruling of the court concerning the Atrato river is based on the negligence by the State to provide the (indigenous) community with a healthy environment. The verdict was that the Atrato river and its tributaries should be recognised as an entity with rights and that a custodian should be established to uphold these rights. This custodian consists of representatives of the government and ethnic communities that live in the Atrato river basin. Again, the connection between (ethnic) culture and nature is stressed. Importantly, it is stated that "justice of nature should be applied beyond the human scenario" (section 9.31) (Atrato river ruling, 2016).

4.2.5 Ganges and Yamuna rivers, India

The Ganges and Yamuna case is different from the examples mentioned above, in the sense that the matter is currently *sub judice*[15] of the Supreme Court and the order on legal personhood is put on stay (I. Chaturvedi, pers. comm.). The order was issued in 2017 by the High Court of Indian State Uttarakhand, stating that the Ganges and Yamuna rivers, its tributaries and "every natural water flowing with flow continuously or intermittently of these rivers" (Uttarakhand High Court Ruling, 2017, no.19), should be granted legal personhood, "with all rights, duties and liabilities of a living person". The rivers are believed sacred in the Hindu culture of India. The "deep spiritual connection" of the Hindus with the rivers forms the basis of the legal personhood, as a "Hindu idol" is considered a juristic person, that requires a human guardian for its "possession and management" (Court ruling no.12). What prompted this verdict is not explained, only that the "Rivers Ganga and Yamuna are losing their very existence" (Court ruling no.10). The purpose of legal personhood is also not argued, other than that "there is utmost expediency to give legal status as a living person/legal entity" (Court ruling no.18). In the Court ruling, custodianship is appointed to the Director NAMAMI Gange, the Chief Secretary of Uttarakhand and the Advocate General of Uttarakhand, for protecting, conserving and preserving the rivers and tributaries, as well as promoting their health and wellbeing (Uttarakhand High Court ruling, 2017).

Pending the ruling of the Supreme Court, the rights and legal personhood of the Ganges and Yamuna rivers have not been implemented and it is unlikely that it will be, because the mandate of the High Court in this matter is questioned by the Supreme Court. The connection of Hindu culture with the natural system does not necessarily lead to care for the river in terms of environmental standards. The rivers are considered sacred and are being revered in everyday life of the people, but this also means that they throw offerings such as flowers, including plastic (wrapping) materials, into the river and they use the rivers for sewage. Therefore, the big problems of pollution in the rivers are in part tied to the reverence of the river instead of being ameliorated by the notion of a sacred connection. Furthermore, there are administrative and policy issues with legal personhood because the river systems are transboundary and decisions on the matter in India thus affect neighbouring countries as well (I. Chaturvedi, pers. comm.).

4.2.6 Comparative analysis of examples of rights granted to river systems

The essence that all examples above have in common is the recognition of nature as a living entity that humans partly depend on, rather than simply a harvestable resource that humans can profit from as they please. How that living entity is defined differs per case. Legislation in South-America pertains to nature as a whole, while in other parts of the world, specific rivers have been granted rights. How such a river or natural entity is demarcated also varies. New Zealand includes the tributaries and bed in Te Awa Tupua, only as much as the extent of the bed at its fullest flow without overtopping its banks and including subsoil, water and the air above (Te Awa Tupua Act, 2017), while Australia

[15] Under judicial consideration and may therefore not be publicly discussed.

explicitly includes the adjacent lands, and even considers the Urban River Lands in its Yarra River Protection Act (2017).

Furthermore, in all instances there is a spiritual component tied to the beliefs and connection with nature of the (native) peoples of these countries, although not all lead to a healthier environment. The way in which custodianship to protect and uphold the rights or value of the natural entity is arranged, is similar everywhere, although the shape of the proposed advisory institutions is not always clear, nor the extent of their clout in representing nature for decision-making or in the court room. Usually, representatives of native peoples and stake-holders take seat in the Custodian organisations. For Te Awa Tupua and Yarra, the representation of nature is outlined clearest of all cases.

Once legislation on rights of nature or natural entities has been passed, it has proven to be difficult to enforce (Cano Pecharroman, 2018). Importantly, the intentions of custodianship are to reinforce the position of nature against exploitation or destructive interventions. In the examples above, economic activities are allowed only if they do not harm nature, except for the Indian case, which does not mention economic interests. As Custodianship was established recently, its development and how such legislation will play out in the governance of natural (river) systems is yet to be observed and experienced (Cano Pecharroman, 2018).

4.3 The Ems-Dollard as a natural entity?

The question is now, whether the Ems-Dollard would benefit from a form of custodianship, legal rights or legal personhood, as exemplified in the previous section. First and foremost, the Ems-Dollard is very different from the examples described in the previous section, in several ways. The legislative systems of the Anglo-Saxon countries (Common Law) are different from that in Germany and the Netherlands (Civil law) and legal personhood would perhaps be of lesser importance for standing in court in Germany and the Netherlands. The native culture component that weighs so heavily in the countries that have adopted legislation on natural entities is non-existent in Western Europe. Germany and the Netherlands do not have an indigenous community, nor does nature take a prominent place in the (originally mainly Christian) religious culture or spiritual beliefs. There is therefore not an innate bedding here for looking at nature in the sense of a living entity.

And then there is the matter of the comparison of the natural system itself, in this case the rivers and their naturalness. Even though pollution is a problem in the Atrato, the Yarra flows right through the city of Melbourne and intervention such as construction works (e.g. jetties) and gravel extraction have taken place in the Whanganui, these rivers are still far more natural than the Ems, that has been shaped by human intervention beyond its natural characteristics.

Nevertheless, say that the Ems-Dollard system were to be acknowledged as a natural entity. How could this be implemented? There are three possibilities, based on the known instances of rights of nature. Although these possibilities are discussed here separately, they should be considered in coherence with each other, for one does not necessarily exclude another but rather they are complementary. The possibilities are (i) establishing a custodian to give a voice to the interests of the natural components of the Ems-Dollard, (ii) recognising the Ems-Dollard as a natural entity and anchoring its rights in legislation, (iii) granting legal personhood to the Ems-Dollard. The “natural entity” and “legal person” will also require a custodian to represent the natural system.

(i) Establishing a custodian

A custodian for the Ems-Dollard should primarily be devoted to representing the interests of the natural system, i.e to give a voice to the “will” of the river and estuary. In the examples of section 4.2 a custodian is an office or council with people representing authorities, interest groups and stake-holders. In the Ems-Dollard however, these parties already take seat in deliberation platforms such as E&E and are involved in decision-making (e.g. IMP, Masterplan Ems 2050). There is already quite a complex organisation structure for management of the Ems-Dollard and its catchment. For example, one of the proposed measures (M53) in the IMP (2016), that proposes to create a cooperative alliance ‘Integrated Estuarine Management Ems-Estuary’ (IEMEE), received criticism and was toned down to a bilateral multidisciplinary cooperation platform, in order to not create extra authoritative bodies or new competences. An additional layer or body of management would only add to the complexity of managing the Ems-Dollard.

A custodian could also be a person or small group of experts that would join existing platforms and promote and defend the natural characteristics of the river and estuary. Such a person or persons should be equipped with knowledge of the functioning of riverine and estuarine systems in natural balance. Even if such expertise would be added, perhaps as representatives of the already involved advisory institutes (e.g. Deltares, Royal Haskoning DHV) or NGOs, then it would still be another voice at the table that speaks just as loudly as that of the economic stake-holders. The representation of the "will" of the Ems-Dollard thus requires more clout or legal capacity.

Another form could be to designate any of the existing parties or authorities as a custodian and thereby vesting a greater say in the voice of that party or authority. As the primary aim of the custodian should be to advocate the interests of the river and estuary, NGOs would be an obvious choice. Alternatively, (one or more of) the authorities could be a custodian, but the problems here are that the authorities have more priorities than the sole interests of nature. In the Netherlands, the three ministries that govern nature, water and climate, also administer agriculture, infrastructure and economic affairs, respectively. Conflicts of interest cannot be excluded. In Germany, the different administrative levels of federal and state government and their ministries (water is a federal affair and nature is under state governance) complicate matters. Moreover, the transboundary character of the Ems-Dollard system would perhaps be better represented by a transboundary oriented custodian. Subcommittee G of the Border Water Commission currently is the competent authority of the disputed area for the WFD. As a custodian, the Subcommittee G could oversee the Ems-Dollard, or rather the Ems basin, if the custodian would be assigned to the entire IRBD. Their working group 'water quality' should then be extended toward hydromorphodynamics and ecology in order to represent and advocate the "will" and "wellbeing" of the riverine and estuarine system.

The question remains, however, what the benefit of a custodian representing the Ems basin or Ems-Dollard would be over anchoring the interest of nature in legislation. Would the custodian always have the deciding vote in decision-making? Would a deciding vote be necessary if the interest of nature would be sufficiently warranted in legislation? As Stone (2010) also pointed out, legislation on nature to back up the voice of the custodian would still be necessary.

(ii) Natural entity and anchoring in legislation

At present, nature conservation policy is anchored in the Bundesnaturschutzgesetz (German federal law) and the Wet Natuurbescherming (Dutch federal law). German states have their own implementation laws stating the particulars for their states in addition to the federal law. The importance of nature is acknowledged as "Nature and landscape need to be protected for their intrinsic value and for the basis of life and health" (Bundesnaturschutzgesetz art. 1.1). Dutch nature conservation law refers to the policy document "national nature vision" for the view on governance of nature. The natural surroundings are deemed important for society and, according to the Ministry of Economic Affairs, has lost contact with society because the policy on nature had been focused on the intrinsic value of nature itself (Ministry EZ, 2014). This intrinsic value, however, does not have the same meaning as elsewhere in the world, such as the (partly spiritual) views of the indigenous peoples in the Te Awa Tupua example. In the Netherlands, new policy on nature therefore revolves around "the creating and responsible human, and with that the energetic society" (Ministry EZ, 2014, p.6). The "view on nature" itself is not anchored in law and can thus be easily adjusted in any direction, in case of a change in opinion, policy or change in political views (elected government). Natural systems are preferably considered on a larger scale than specific species and habitats, and as a resource for societal and economic development (Ministry EZ, 2014, p.6).

Additionally, article 21 of the Dutch Constitution states that the government has a duty of care towards the "habitability of the land and the protection and improvement of the environment". This could be explained in a broad sense as the government being obliged to safeguard the natural environment. However, the official explanation also includes defence against water as well as care for the waters (Nederlandse Grondwet). The German

federal constitution does not include a duty of care on the environment (Grundgesetz für die Bundesrepublik Deutschland).

Both countries have an economic component in their nature conservation laws. If Dutch spatial planning projects are in conflict with nature, the damage should be mitigated whenever possible or otherwise compensated (Wet Natuurbescherming, art. 2.8). In Germany, all measures for nature conservation and landscape development need to be weighed against the effort required. Damage to nature should be avoided, but if inevitable, compensation is required either by means of other measures or money. The use of certain public services and utilities, such as maritime and inland navigation, flood protection and public transport, needs to be guaranteed in decision-making on nature projects. For agriculture, nature may not "be affected more than is necessary for sustainable yield" (Bundesnaturschutzgesetz, art. 5). Protection of areas with particular natural value occurs via N2000 sites, but also National Parks, natural monuments (NL and D), landscape protection areas, nature parks, protected landscape elements and protected biotopes (D). Exemptions for activities that infringe nature conservation (N2000) areas can be granted in case of imperative national interest and if there are no alternatives available (Bundesnaturschutzgesetz art. 34.3; Wet Natuurbescherming art. 2.8), or if the implementation of policy is disproportionate with the interests of nature (Bundesnaturschutzgesetz art. 67).

The difficulty in upholding the rights of nature in current Dutch and German law, is that there is a prominent disclaimer for societal, and especially, economic interest, although legislation is more stringent for protected areas. On the contrary to the examples of rights of nature discussed in section 4.2, there is no vesting in Dutch or German law of the importance of natural areas and natural processes in their own right. This way, a loop hole will remain for economic and other interests in case of conflict with nature conservation measures. Previously discussed examples of rights of nature in law also mention sustainable economic development in relation to nature, but the difference is that in these cases economy is to be brought in balance with nature, while law and policy in Germany and the Netherlands rather bring economy and nature in balance with each other, i.e. nature may need to give way to economic interests. In the Ems-Dollard this is illustrated by the deepened channels, they are much desired for navigation but are also fundamental to the ecological problems. Re-naturalisation of the hydromorphodynamics would thus entail a more natural channel depth, which would automatically lead to rearrangement of the use of the water ways.

After the examples from the laws of Ecuador and Bolivia, the position and rights of nature and natural objects would be better upheld and protected if Germany and the Netherlands included in their respective laws statements on the basic values and rights of nature. The possibility to declare natural systems a natural entity as described by the Yarra example would further strengthen the position of the rights of nature. In the case of the Ems-Dollard, this natural entity should at least consist of the river Ems and estuary, including bed, subsoil, banks and floodplains, or in a wider sense, including the (upstream) tributary rivers. The canals draining into the Ems (mainly further upstream) and dikes are man-made objects and it is debatable whether these can be considered part of a 'natural' entity (for further discussion, see chapter 5). However, delimiting a natural entity does not do justice to the interconnectivity of the system within the wider setting of the natural environment. For the Ems-Dollard, for example, excluding the Waddenzee from the natural entity, would pose problems regarding the estuarine dynamics and processes that interact between the estuary and the Wadden Sea.

(iii) Granting legal personhood

A step beyond recognising a natural system as an entity and anchoring rights of nature in legislation, is granting legal personhood. The only known case so far is Te Awa Tupua, the natural entity of the Whanganui River, represented by its custodian Te Pou Tupua. The natural entity was acknowledged and subsequently rights were transferred to this natural entity to give it legal personhood. In essence, the river thus belongs to itself and no longer to the state or other authority. With that come all responsibilities of being a legal person, such as liability and the possibility of being sued in court. The Te Awa Tupua Act (2017) is

relatively recent and consequences or how actual legal personhood of a natural entity plays out is not yet known. Legal personhood is more important for Common law judicial systems than for Civil law (of e.g. Netherlands and Germany) (see section 4.2)

In the potential case of granting legal personhood to the Ems-Dollard or entire Ems system, an additional difficulty is that the natural legal person would reside in two countries instead of one. Germany and the Netherlands would both have to forgo control over part of their territory. As they have shown to already have difficulty agreeing on the location of the international border within the estuary, it is unlikely that they would willingly transfer ownership of the estuarine and riverine territory to another entity. If the Ems-Dollard would become a legal person, under whose jurisdiction/law would this natural entity then be? The greater part of the Ems system lies in Germany, so that seems to be the obvious choice, but the Netherlands would likely not willingly relinquish that much control, especially while they would still experience the consequences of decisions and measures taken in the German parts of the system. On the other hand, in case of legal personhood of the Ems-Dollard, governance of the estuarine system could become a transboundary affair entirely, that could then be placed under European law.

Furthermore, the custodian of the natural legal person will need funds for its functioning, restoration and other expenses, for example for legal costs and compensation, in case the river and estuary are sued. In the instance of Te Awa Tupua, the Crown sees to the funding, but how would such a thing be divided between two countries? A limited form of legal personhood that excludes liability would be an option that would at least prevent the river and estuary from being sued (and thus prevent the possibilities of penalties or financial compensation).

The advantage of legal personhood would be that the position of the wellbeing of the Ems-Dollard against other interests could be much improved, and decision-making to the benefit of the natural system and its processes would perhaps be better enforceable in court. It is not certain, however, what the advantage of legal personhood would be over option (ii), anchoring the rights in legislation, also because legal personhood is of lesser importance in Civil law. Regardless, legislation on nature would still be necessary to warrant the rights of the 'natural' legal person. The practical feasibility of legal personhood for this particular riverine and estuarine system appears to be very low even if only because of the transboundary component.

5. Discussion

The cause of the discussion on rights of nature and all matters related is in its origin induced by the disruption of natural systems, dynamics and processes by humans, and the awareness raised by the adverse effects. The Ems-Dollard system is a clear example of an estuarine system in which human intervention has created a cascade of problems that severely disrupts the natural functioning of the system, its hydromorphodynamics (including turbidity) and flora and fauna. Attempts to ameliorate the situation have been initiated since two decades, principally guided by the EU Water Framework Directive. The question is, however, if current policy is enough to address the problems in the ecosystem and how far the results of the efforts will bring the Ems-Dollard towards being a naturally balanced system. This also entails a discussion on the value and importance of naturalness in the environment. After all, humans live and operate within a natural world.

It is customary for science and engineering to observe the functioning of a natural system, to understand the processes behind it and if a process is hampered, to find a solution to try and fix it. Such a solution may be to interfere in the natural system and guide it around the problem and tinker with the system, or to intervene in such a way that the system returns back into balance. The choice between tinkering interference and intervention for balance is the difference between controlling the environment and working with the environment. It is the former that has contributed to the problems in the Ems-Dollard.

What the examples of especially the legal personhood of the Whanganui river and the legislation of Ecuador and Bolivia have emphasised, is the interconnection of humans with nature by

elevating nature to the same level of importance as humans, as far as rights of existence are concerned. Moreover, it recognises the metaphysical element of "life" in all aspects of nature. Is this something science should concern itself with? The traditional basis of science is, was or should be, after all, to objectively observe and act from gained knowledge. Contemplating the role of nature and the 'why' of making choices on for example nature conservation, would appear to entail a decision of allegiance. However, it does not take away from the unbiased view with which science is undertaken. It is actually the choices of weighing the interests of nature that already guide each decision whenever remediation measures invented by science are proposed. Whichever input into (hydromorphological and other) models is chosen requires a decision on the boundary conditions, which are often shaped by humans, and the model output thus represents the extent to which human interference is allowed. For example, the reference state of the surface area of intertidal flats for the WFD was decided to be 1950-1960 (Wielakker et al., 2011) (see box 1). This automatically assumes a certain extent of human interference, as some artificial alterations to the natural system had already taken place. The modelling studies of, for example, Van Maren et al. (2015a,b) into the suspended sediment concentration and anthropogenic forcing factors use historical (reconstructed) bathymetry of 1985 (Van Maren et al., 2015a) or earlier, 1945 (Van Maren et al., 2015b). Again, interference in the system such as channel deepening had already commenced, and a natural reference state to compare anthropogenic influence to is not considered. Therefore, scientists should be aware of the choices they may (indirectly) make in assuming the (boundary) conditions of their object of study.

Although it may be unusual for geomorphologists or other scientists to speak about the "wellbeing" of nature, because that would require recognition that a natural object has a "will" and that it not simply exists, something that is too metaphysical for science, it is important to discuss also these aspects in light of a fully integrated approach to preventing the deterioration of natural systems. Additionally, it allows for communication with other fields of expertise, that do use this seemingly personifying vocabulary. The discussion in this report therefore includes not only the practical scientific view on estuarine systems and management of nature restoration, but also ventures out into the wider scope of observing nature, contemplating the "wellbeing" of nature and its relationship with humans and their actions.

5.1 Shortcomings of current legislation and policy

The way restoration of the state of the Ems-Dollard is currently arranged is through the European WFD, HD and BD, that are transposed and implemented in national legislation. However, the focus of these directives are the ecological status or potential and chemical status. Hydromorphology is only an additional aspect that arises from creating habitats for flora and fauna. Variation in depth, substrate, structure of the river bank or tidal zone, flow quantity and dynamics, and river continuity are considered important for the biological elements, while salinity and dissolved substances (including turbidity due to high suspended sediment concentration) are considered chemical elements (see table 1 in box 1). This subdivision ignores some of the most crucial systemic characteristics of riverine and estuarine systems, namely the interplay between the different aspects of hydromorphodynamics.

Salinity in particular is not merely a chemical characteristic for the chemical state or indicative for the type of flora and fauna that can reside in such waters, it is a vital driving force for estuarine flow and circulation. Turbidity or suspended sediment concentration is an aspect of sediment transport processes and thus of morphology and intricately linked to the estuarine circulation (see sections 2.2 and 2.5). Furthermore, the interaction between abiotic and biotic components is completely overlooked. Eco-engineering species have important influence on the development of morphology (De Haas et al., 2018). Hydromorphodynamics should therefore in its own right be recognised as a characteristic of a natural system, one that provides the canvas for biotic elements, yes, but nevertheless an assemblage of processes that principally exhibits the "will" of the natural water system.

Additionally, hydromorphology appears to mainly be portrayed as a requisite for the biotic ecosystem. The risk here, is that restoration projects may focus on (re)establishing habitats for the sake of having certain habitats such as riparian forests, intertidal flats, supratidal zones etc. of a certain acreage because they desire a complete and static picture of the ideal estuary or river. In reality, natural systems are dynamic and constantly reshape themselves. It may therefore very well be, that

certain habitats are destroyed by natural processes in one place and develop again in another and not all characteristic habitats may continuously be present in the system. EU nature conservation legislation does not recognise these dynamics. The boundaries of N2000 habitats are delimited and conservation goals state that these habitats are not allowed to decrease in extent nor move.

Suppose that the water flowing through a channel would erode part of the mudflats (habitat type H1140), which is not allowed because the areal extent of this habitat type has to be preserved (Ministry LNV, 2008). According to current law and policy, the system would then be in violation of itself, even though it performs nothing but its natural processes. For the particular case of H1140, the explanation of this conservation goal does state that the exact location and surface area may fluctuate yearly because the environment is highly dynamic (Ministry LNV, 2008 section 5.3), which is directly contradictory to its own conservation goal of preservation of area. The "for the benefit of"-condition allows for the extent of one habitat type to decrease for the benefit of another, that has to be under pressure (Ministry LNV, 2008, attachment C). If this condition would be extended to encompass intrinsic hydrodynamics processes of a system, it might provide a (temporary) solution to the problem of preserved areal extent. A different practical implication of hydromorphodynamic processes concerns appointing the location of an international border. According to international law (and the position of the Netherlands on the disputed area) (SGD Eems, 2009; Disco & Van Heezik, 2015) it is customary to define the thalweg as international border if located in a channel system. This means that the international border could potentially move along with the channel dynamics in a river or estuary.

These examples illustrate the complications in the practical application of law and policy. The EU Directives allow for interpretation and customary implementation in the federal law of the member states, but the HD nevertheless states that areal extent needs to be stable or expanding. This shortcoming would therefore be best resolved in EU legislation. The extent of tidal area pertaining to the reference state of the WFD is a matter for the member states and might therefore be adjusted at national administrative level, to better represent the natural hydromorphodynamic processes.

As for the degree to which the EU directives, federal legislation and policy of Germany and the Netherlands, protect nature, there are clauses in legislation that still provide the opportunity for other interests to come before nature. It is up to the authorities to weigh plans when social and economic interests conflict with nature that should be protected under law. The decision therefore heavily relies on the view of humans towards nature.

5.2 Designation as a "living entity"

Considering the Ems-Dollard or any water system as a living entity poses two initial questions: What does "living" entail and what should be considered the entity? Living scientifically refers to all biotic components of nature, such as flora, fauna and micro-organisms, but in the natural entities of e.g. Yarra and Whanganui abiotic components are included as well. This asks for a more integral definition of the concept of "living". For Yarra and Whanganui, the concept of "living" is tied to the cultural beliefs of a spiritual essence within all or certain parts of (abiotic) nature. In South America, indigenous peoples also revere spiritual beings within landscape elements (e.g. Castro & Aldunate, 2003; Allison, 2015). If "being alive" can be viewed as to represent a dynamic state and set of processes and interactions governed by underlying principles (laws of nature) that drive the "will" or characteristics of the river or natural system, then nature's dynamics and processes could be regarded as "living" as well.

As for the "entity", definition of this particular part of the natural system is difficult, but a lack of organizational boundaries could impede custodians in their efforts to act on behalf of the river (O'Donnell & Talbot-Jones, 2018). One could demarcate the river and its tributaries up to and including its banks at full flow, after the Whanganui example, but flooding is an innate property of rivers and the space occupied by the water during floods should also be part of the entity. The definition "full flow" should therefore be specified to bankfull flow or overbank flow. This leads to another decision on the extent to which overbank flow, or flood, is taken into account. The largest floods will occupy the greatest area of floodplain and beyond if the accommodation space is insufficient, but are also rarest with the longest recurrence time. Should the boundaries of the entity be defined by extreme floods that may only occur once every few thousand years? And if not, and such a flood does occur, should the river be blamed for exceeding the space attributed to its entity simply because policy requires a set boundary? If the entity is given rights, it could be liable for damages caused by flooding beyond its

designated boundaries. The accommodation space for floods is often in use as farmland, e.g. seasonal use of floodplains for grazing live-stock. Ownership of the floodplains may then become a complicated matter, as the land is owned by farmers, while it also is part of the natural entity that may have rights of its own.

Furthermore, the water itself should be part of the natural entity, for its hydrodynamic processes shape the water system. However, water enters and leaves the natural entity (e.g. via rainfall and outflow into sea) and would therefore only temporarily be part of the entity. Groundwater bodies are connected to the surface water system, which is the focus of the natural entity, but may not necessarily follow the same drainage divide as the surface water bodies (e.g. on sub-basin scale in the Ems basin, SGD Eems, 2005). Should groundwater then be considered part of this entity because of its interconnection? This would extend the boundaries of the natural entity to far deeper below the subsoil than merely the river bed. Granting rights to nature as a whole, after the examples from Ecuador and Bolivia, would circumvent this problem of defining the natural entity.

5.3 The Custodian

In all options of granting rights to a specific natural system (see chapter 4), a custodian needs to be appointed. Apart from the previously discussed fact that this could add yet another layer or administrative body to the already extensive web of parties involved in managing the Ems-Dollard, which would likely be undesirable, there is the issue of who or what this custodian should be. For the Yarra, Atrato and Whanganui rivers, the custodian takes the form of an (advisory) commission in which indigenous peoples represent their natural entity along with representatives of other parties. The job of the custodian is to speak on behalf of the natural entity and advocate its interests (Stone, 2010). The custodian should therefore be able to determine what the "will" and "wellbeing" of the natural entity is. This comes down to having knowledge of the natural processes in the first place, for that is what ultimately expresses the "will" of a natural water system. However, the representatives of these three river systems as described in their respective legislations or court rulings are mainly distributed among parties with interest in the river systems and do not specifically require certain expertise, except for the Yarra custodian, where there are two "skills-based" positions reserved. The skills that are specified (see footnote 12) do vary in a range of fields, so that ultimately, it is still well possible that the custodian commission remains without hydromorphological and ecological knowledge. If the interests of the river would truly be represented well, scientific knowledge of the actual natural system and processes should be a prerequisite.

A framework to qualitatively or quantitatively assess the state of the natural system is yet to be developed for the known instances of rights of nature. The Yarra River Protection Act does mention that such a strategy needs to be established and the development of the Strategic Plain is currently still ongoing.[16] The EU directives are in that way much more concrete at providing guidance for decision-making, albeit with the deficiencies mentioned above.

Conceptually, the wellbeing of natural systems as opposed to other interests are better safeguarded in the Yarra, Whanganui, Ecuador and Bolivia cases than in the EU directives. For the Ems-Dollard, economic interests are anchored and warranted in legal and policy documents (e.g. Masterplan Ems 2050, E&E, ED2050). This means, among other things, that large ships should still be able to navigate the estuary and the Ems river, automatically entailing that the channels need to remain sufficiently deep for navigation. Yet, the unnaturally deep channels are one of the most important causes for the disruption of the natural balance in the Ems-Dollard. If the aim is to seriously re-naturalise the river and estuary, adjustments in the use of the waterways are necessary. The harbours in the estuary could adapt their activities so that ships with lesser draught are sufficient.[17] In the river Ems, the construction activities are mainly related to the shipyard in Papenburg. The question is whether having a builder of very large cruise ships at a location 30km upstream in a small river is sustainable. However, moving the shipyard to a location near the coast is so far not considered an

[16] Melbourne Water is in charge of developing the Yarra Strategic Plan, a process with several phases of deliberation with Traditional owners, public entities and other interested people. A conceptual plan is not yet available. www.melbournewater.com.au/about-us/our-customers/yarra-strategic-plan

[17] For example, the approach channel towards Eemshaven needed to be deepened in order to accommodate larger bulk carriers for the new coal-fired power station (2015) (Disco & Van Heezik, 2015). However, in light of the energy transition necessary to mitigate climate change, permitting this decision was questionable.

option (Masterplan Ems 2050, 2015). The WFD offers some ease of restrictions for artificial or heavily-modified waters, but the question remains if the aims formulated in the RBMP, IMP and MIRT of a more natural morphology would be achievable with the current intensive use of the waterways. It is deemed unlikely that the "good status" or "good ecological potential" required for the WFD will be achieved by 2027 (P. Dankers, W. Iedema, pers. comm.).

5.4 On the "natural state"

If the aim of restoration of the Ems-Dollard natural system is to reach a dynamic state in which the system keeps itself in balance, the "natural state" of the Ems-Dollard needs to be defined first. This is a difficult task, because the system has been shaped by human activity for centuries. What is more, the Ems-Dollard would not even exist as it does, where it not for human intervention. After all, the sea ingressions occurred because of dike construction around land reclamations and the ingressions that formed the Dollard would not have caused such a widening of the tidal basin if the hinterland had not subsided, a consequence of embankment and land reclamation.

The Dollard has been gradually silting up since the 15th century, and it is expected that this process will continue until the tidal basin is proportional to the hydrodynamics again. This sedimentation process may cause suspended sediment concentrations to be elevated, even if the main causes for the high turbidity are mitigated (ED2050, 2017c). The accommodation space for fine sediment (quiet low dynamic zones, where fine particles can settle) is currently lacking, only sand settles in the channels. Sea levels are expected to rise due to climate change, and the prognosis is that sedimentation in the estuary can keep up with sea level rise (under the current predictions), except in the mid-estuary, where the flats consist of sand and sedimentation is limited by transport processes (P. Dankers, pers. comm.). A long-term vision on a natural Ems-Dollard should include the changing boundary conditions of climate change, sea level and changing fresh water input from precipitation.

Knowing that the Ems-Dollard system was formed under (indirect) influence of humans, that the system was heavily modified by human intervention over the past two centuries and that the future holds changes in boundary conditions that can only be predicted to a certain extent, would it be sensible to look to the past for a "reference state" of what the system should look like, as is carried out under the WFD? The risk here, is to force the Ems-Dollard into a new straitjacket, a well-intended one, but still an image of a natural state governed by boundary conditions of the past and by the desire to create certain and specific ecological habitats that do not necessarily fit the current natural development of the system. How the system will develop to equilibrium and what this dynamic equilibrium entails is still unclear. In 2019, the expert group of ED2050 will contemplate the possibilities of the future development of the Ems-Dollard (W. Iedema, pers. comm.). In any case, target images and decisions on measures, either construction or removal, are a product of the way in which humans view nature. It is this view, that has started to change over the past decades.

5.5 Humans and nature

The fundamental basis beneath the ongoing debate on rights of nature, custodianship and legal personhood is the question on how humans perceive themselves in relation to nature. So far, the debate is rooted in the fields of Law, Humanities, Philosophy and Indigenous culture for example, and is virtually absent in the Natural Sciences (e.g. Earth Science, Ecology). Illustrative is the Expert report of the UN on Harmony with Nature. Many experts from different fields contributed, but none from Science (UN, 2016),[18] even though it might be expected that a discussion about nature would benefit from knowledge on the functioning of nature itself. Science observes and investigates objectively, rather than give meaning to an interpretation. The consequences of scientific results, developed plans and tested methods and measures,[19] however, do have an impact on natural systems, and therefore the scientist might want to (or should) take into account the effects of the research. It is easy to confine

[18] "Experts of the Knowledge Network on Harmony with Nature participating in the first virtual dialogue" in the fields of Earth-centered law, ecological economics, education, holistic science, humanities, philosophy/ethics, arts/media/design/architecture, theology/spirituality (UN, 2016).

[19] Whether it is fundamental science, applied science researching the functioning of nature, or science based engineering.

oneself to the frame of scientific conduct, but are we not all in principle human beings sharing existence with each other and a natural planet? It is the view on humans being a part of nature that initiated the granting of rights or legal personhood to river systems, mainly brought under the attention of governments by indigenous peoples standing up for their rights, legacy and world views (see section 4.2). The UN recognized the "rich history of understanding the symbiotic connection between human beings and nature, that fosters a mutually beneficial relationship" that indigenous cultures and ancient civilizations carry with them. In this way, all damage to nature would ultimately reflect back to and damage humans themselves (UN, 2010).

This discussion on humans and nature does not necessarily remain philosophical, there is also a practical use in contemplating the matter. It is the conviction of humans that nature could be adjusted and shaped for the benefit of society and economic use that has shaped the Ems-Dollard over the course of centuries. The "battle against the water" is well known in the collective memory of the Dutch people, and engineering works have been going on for centuries, in line with the policy that water needs to be contained and redirected as humans see fit (Van Heezik, 2006). The heavily deteriorated state the Ems-Dollard (eco)system is in now is the result of human actions, and now the question is what to do about it. Any attempt to re-naturalise the system requires consideration on the interaction with human activity in the area. Can the system only be natural if humans were in no way involved, and thus essentially would have to move out of the river basin entirely? In this scenario, there is still a division between human and environment. If there is any conclusion that can be drawn from the discussion on rights of nature, it is that humans are part of nature, as also expressed by Grear (2011), and that the right of existence falls to the combination of humans and nature.

Rights are an artefact of human society designed for use in practical arrangements, so perhaps simply 'interconnected existence' would define the relation of humans with nature. Germany and the Netherlands do not have an indigenous culture that relates itself with the natural surroundings, and so, stewardship of caring for the environment and legacy for future generation would therefore probably be closest to a connection of humans with nature in this region. The choice for the future of the Ems-Dollard (eco)system and the natural state that is envisioned in policy making, based on scientific understanding of the system and the value that humans put on nature, is therefore one that has to find a balance in a reciprocal co-existence, without attempting to overpower the functioning of nature.

The question remains how this co-existence of humans and nature should be regarded and when the presence of humans becomes a disruptive interference in natural systems. This can be illustrated by the example of beavers building a dam in a river, as they do in their natural way of living. If the river is only to follow its own natural course, the beavers could be seen as a disruption, for their actions cause the development of a lake upstream of the dam. As a consequence, the river may also change its course. On the other hand, if the beavers are viewed as a part of the greater ecosystem of nature that also encompasses the hydromorphodynamics of the river, the beaver dam would also be part of the ecosystem, where beavers and river together find a new balance of co-existence. The extent to which humans build their more intrusive version of a beaver dam (including all adaptations and construction works) goes beyond co-existence, for it disrupts the functioning of the river and the ecosystem that the river supports. The challenge is to find a way of interconnected co-existence where both humans and the natural system can function in a healthy balance. The answer is not straightforward nor easy to accomplish, but a dynamic process towards an interactive equilibrium, just as the natural functioning of a natural system always demonstrates.

6. Conclusion

The ecological state of the Ems-Dollard river and estuary is very poor as a result of extensive human interventions and construction works for the benefit of navigation, harbours and an inland shipyard. The main problems are (i) the tidal basin surface area that is not in proportion with the hydrodynamic boundary conditions of the system, (ii) the changed morphology due to straightening and especially deepening of the channels, (iii) the elevated tidal range and protrusion of the tidal wave, (iv) the high suspended sediment concentration, changed estuarine turbidity maximum (ETM) and

anoxic conditions, (v) the development of a fluid mud layer on the bed, and interactions between these aspects.

Over centuries, the development of the system has been shaped by (direct and indirect) human interference, making it difficult to determine a "natural state" with undisturbed conditions, that can be taken as a reference state for implementing EU Directives and as the "well-being" of the system in the context of rights of nature. The important properties and characteristics of a natural Ems-Dollard concern the proportions of the tidal basin; the tidal wave; open connections with the hinterland; the salinity gradient; dynamic morphology; suspended sediment concentration and ETM; flow velocities and water quality (section 2.5). These also serve as the "needs" of the Ems-Dollard, that have to be defined if legal rights were to be granted to this particular riverine and estuarine system.

Governance of the Ems-Dollard is a complicated affair for various reasons. Because of the disputed border area in the estuary, governance is arranged among Germany, the Netherlands, and Subcommittee G of the Border Water Commission. Responsibility and policy-making of water and nature is spread over different administrative levels that do not always pair well, especially in transboundary cooperation. Plans to ameliorate the ecological state of the Ems-Dollard where advanced by the EU Water Framework Directive and the Habitats Directive and Birds Directive. Legally binding engagements between the authorities, NGO's and economic stake-holders warrant economic interests (importantly, accessibility of harbours and an inland shipyard). It is therefore questionable whether these plans are adequate in achieving the aim they were designed for, namely to ameliorate the state of the Ems-Dollard towards a "good" ecological and chemical status under the WFD, and meeting the "conservation goals" of the HD and BD. It is very likely that the aims of the EU directives will not be achieved by 2027.

Shortcomings of EU directives include the set standards for preservation of the areal extent of habitats such as mudflats, and the fact that the abiotic characteristics are only considered in terms of an additional aspect for the creation of habitats for flora and fauna. The boundaries required for the designation of HD habitats, e.g. tidal flats, are not suitable for a dynamic system such as a river or estuary. The river or estuary would be in violation of itself if its own natural erosion and sedimentation processes destroy or create tidal flats, for example. Hydromorphology entails an intricate interplay between components such as water, flow, tide, sediment, salinity that drive riverine and estuarine processes. Focus in policy making lies on an end goal of an envisioned habitat, but hydromorphological processes ultimately determine the type of habitat that a system will develop, and their importance should therefore be acknowledged as such.

In order to explore whether a form of legal rights would aid the re-naturalisation of the Ems-Dollard and provide nature with a stronger position against societal and economic interests, the following findings were discussed:

- Appointing a custodian that would promote and advocate the "will" and "wellbeing" of the river and estuary. The governance structure and management of the Ems-Dollard is already extensive and complicated, so another authority would only add to the complexity of the current web. Having a custodian join existing platforms would be just another voice at the table with as equal a voice as other interests, and would not significantly improve the position of the interests of the natural system. Appointing a custodian still requires legislation on the protection of nature to provide a legal basis to appeal to. A possible custodian could be Subcommittee G.
- Anchoring rights in legislation: currently, national legislation of Germany and the Netherlands, as well as EU directives, still provide the opportunity to undertake activities that harm (even protected) natural systems if there are "overriding reasons" of public importance. Warranting the importance of the naturalness of natural systems in legislation would benefit the interests and position of nature. Recognising a natural system as a natural entity, however, brings along complications in demarcating the system and its natural reference state, and thereby does not to justice to the interconnectivity of natural processes.
- Granting legal personhood: does not have the same impact or effect in court in the Civil Law based judicial systems of Germany and the Netherlands, as it does in the Common law systems of Anglo-Saxon countries. The motivation of legal personhood of other instances relies heavily on indigenous cultures and their connection with nature, which Germany and the Netherlands do not have. Importantly, the Ems-Dollard is located in two countries and legal personhood would not be practical because the legal person would fall under jurisdiction of both countries. A solution could be to place the natural entity under EU law.

Given the framework of EU and national legislation and management of the Ems-Dollard, the most feasible option was found to be improvement of current legislation to warrant the interests of the riverine and estuarine system, and thereby emphasising the importance of the naturalness of the natural system.

Re-naturalisation plans and projects for the Ems-Dollard require a weighing of interests of the natural system and those of society and economy, which has proven to be a sensitive matter. The present (socio)economic use of the waterways, for which an increased channel depth is required, prevents hydromorphodynamics from returning to a natural balance. The future of the Ems-Dollard requires contemplation of the role of humans in the system. To what extent can human activity be regarded a co-existence in balance with the naturalness of the system, and when do human presence and activities start to disrupt the natural functioning of the system, as is currently happening? It is important that this debate does not remain confined to Law and Philosophy, but that it also extends towards Science and Engineering. This does not take away from an objective scientific view towards natural systems, but merely enriches an integrated approach towards studying nature. It is also necessary for practical matters such as determining the reference state for EU Directive and decisions on human activity in natural systems in general.

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