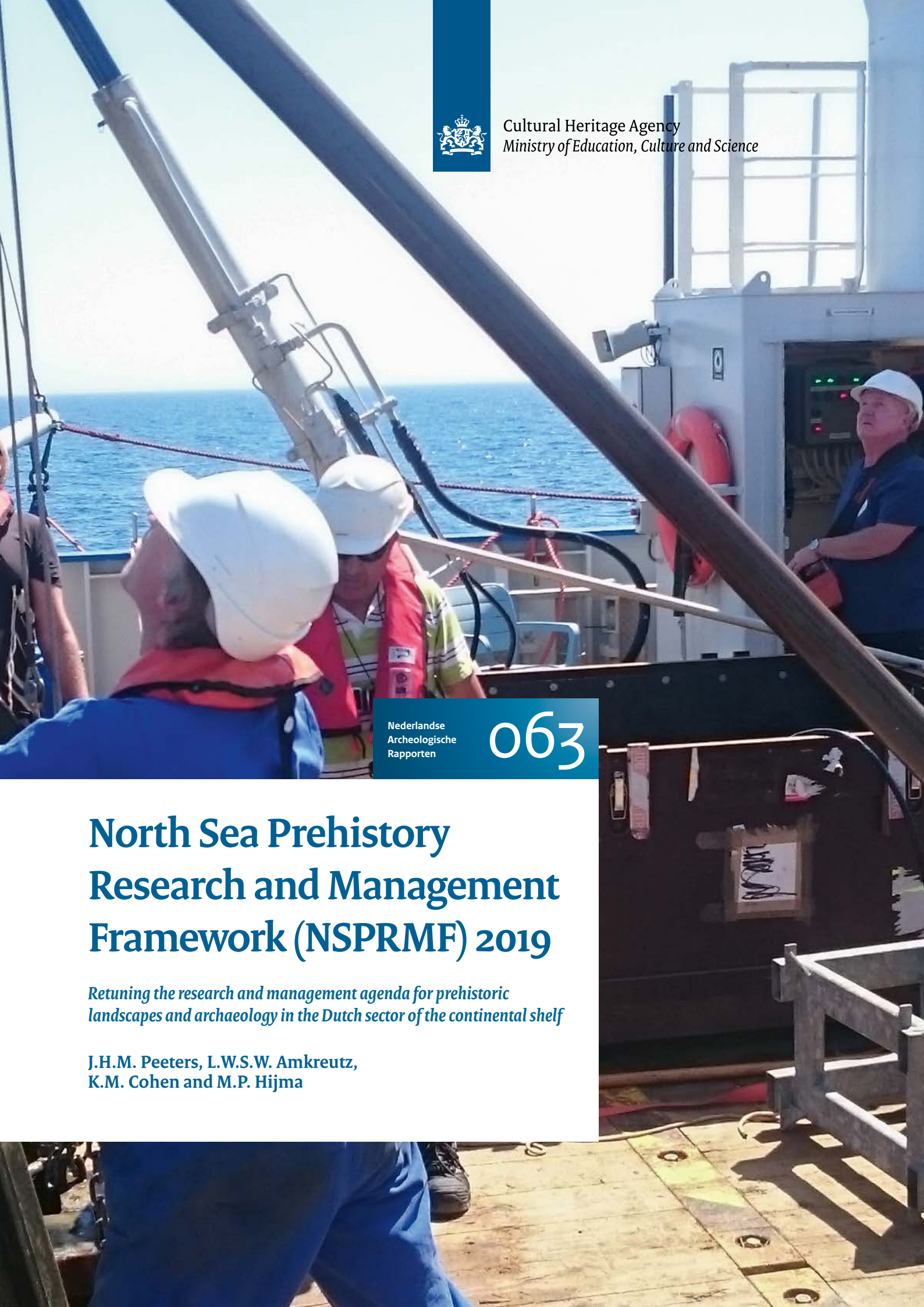

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North Sea Prehistory Research and Management Framework (NSPRMF) 2019

Retuning the research and management agenda for prehistoric landscapes and archaeology in the Dutch sector of the continental shelf

J.H.M. Peeters, L.W.S.W. Amkreutz, K.M. Cohen and M.P. Hijma

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Inhoud

Preface

An important and sometimes overlooked element of the maritime cultural heritage of the southern North Sea are the submerged prehistoric landscapes and prehistoric remains which are embedded in the present seabed. Parts of this cultural heritage may be affected by numerous activities which will occur in the coming years in the southern North Sea. Activities such as sand and gravel extraction, the construction of windfarms, a search for oil and gas fields and the maintenance of shipping routes will all have an impact on this heritage.

A new national maritime programme (*Programma Maritiem Erfgoed Nederland*), initiated by the Dutch Ministry of Education, Culture and Science and implemented by the Cultural Heritage Agency of the Netherlands aims to safeguard and investigate this valuable maritime cultural heritage. The submerged prehistoric heritage is one of the elements in this programme. In this respect, the goal is to create a network of actors comprised of governmental and non-governmental organizations, the aggregate industry, research institutions, maritime heritage companies, other maritime stakeholders and the general public to access, develop and preserve the unique value of this maritime cultural heritage.

Fortunately, we do not have to start from scratch, as about ten years ago a research and management framework was devised. This North Sea Prehistory Research and Management Framework (NSPRMF) was published in 2009 and aimed to provide an agenda for the research and heritage management of submerged archaeological sites and relict landscapes in the Dutch-Belgian and British parts of the southern North Sea. Now, a decade later, new input can be added to this framework, based on renewed attention being paid to this part of our cultural heritage.

To this end, the Cultural Heritage Agency of the Netherlands commissioned one of the original authors to update the framework. With the results and experiences of the past ten years now integrated, the framework has been revitalized. In general, the topics and challenges mentioned in the initial report remain relevant and important. This report looks back at the achievements of the past decade and concludes that while good work has been done, there is still much more to be done to ensure sufficient care of this submerged heritage. It is clear that several projects have been successful, but also that in the present and future more attention must be given to this aspect of heritage management. Furthermore, it is obvious that regulations, practices and work-flows, which are embedded in practices and experiences in heritage management onshore, are not easily copied or applicable offshore. Although ten years have passed, this report provides suggestions on how to move forward in this respect.

The Cultural Heritage Agency of the Netherlands is not able to resolve all of the issues and address all of the recommendations mentioned in this report. However, there some recommendations which the Cultural Heritage Agency of the Netherlands has identified as the place to start:

- Stimulating palaeoenvironmental analyses as an integral part of palaeolandscape mapping and enlarging our dataset as input for contextual models;
- Supporting the registration and contextualizing of ex situ (stray) finds;
- Facilitating reuse and reprocessing of existing and new (geophysical) data;
- Facilitating methodological experimentation
- Maintaining a national portal with up-to-date maps and information, and delivering this information to international portals

The focus on the above-mentioned recommendations is a start but cannot be realized overnight. Heritage management is a task for society as a whole and collaborations remain the key. Therefore, collaborations between heritage management agencies, governmental and non-governmental organizations, the aggregate industry, windfarm developers, the scientific community, archaeological companies, museums, private parties and others are imperative.

Within the new national maritime programme, the Cultural Heritage Agency of the Netherlands will take responsibility for bringing the management of our maritime cultural heritage to the next level. At the same time, this framework is also intended to ensure other parties involved in developments in the North Sea assume their responsibilities with respect to the submerged cultural heritage.

It is essential to recognize that the way heritage management is realized in each project will be unique. However, these project-specific solutions should be inspired and directed by general guidelines. The North Sea Prehistory Research and Management Framework 2019 provides a sound basis for these guidelines.

Bjørn Smit & Barbara Speleers

Project leader & Programme manager
Programma Maritien Erfgoed Nederland

Cultural Heritage Agency of the Netherlands

Summary

The *North Sea Prehistory Research and Management Framework (NSPRMF) 2009* set out to provide an agenda for the research and heritage management of submerged archaeological sites and relict landscapes in the Dutch-Belgian and British parts of the southern North Sea. The framework first and foremost focussed on: (1) maximisation of archaeological information arising from offshore developments (spatial, economic); (2) stimulation of the study of archaeologically relevant materials and deposits to broaden the knowledge base for archaeological and management purposes; (3) stimulation of public understanding and awareness of the past, and fostering of a shared sense of responsibility among developers, decision makers, and scientists; (4) development of a firm basis for heritage management judgement, consultancy, and decision-making, notably an internationally recognised and scientifically accepted set of resource assessments and research agenda.

In view of the vast body of work that has been carried out since the production of the NSPRMF 2009 and the ongoing developments in and around the Dutch sector of the continental shelf, and in order to set a fresh baseline for management purposes for the coming years, the cultural heritage agency of the Netherlands has requested a synthesis and evaluation of published material and other spin-offs in the context of the initial aims of this framework. The present report provides the outcome of this analysis. It is structured into three parts: a look back at the NSPRMF 2009 (chapter 2), an evaluation of the current state of affairs in relation to the priorities set in the NSPRMF 2009 (chapters 3 and 4), and a look forward to opportunities, dilemmas, and choices, in order to retune or redefine priorities and present possible strategies applicable to the Dutch sector of the North Sea for the coming years (chapter 5).

Over the past 10 years, a lot of research has been conducted, in various forms, that is of relevance to the research priorities of the NSPRMF 2009. The extent to which these priorities are met is variable.

Efforts have been geared towards gaining a better understanding of geological factors affecting the taphonomic histories of submerged prehistoric landscapes, as well as those of archaeological and palaeontological finds. Various studies have provided insight into sea-level fluctuation and changing palaeogeography, factors that are of direct archaeological relevance for our understanding of prehistoric human–environment interrelationships and socio-cultural processes.

As yet, the collection of good data points appears to lag behind. Significant results have been obtained with respect to underwater investigation of sites (Rotterdam-Yangtzehaven), the geological contextualisation of finds with limited context information (Middeldiep, Rotterdam-Maasvlakte 2), as well as systematic inventorying and scientific analysis (AMS ^{14}C dating, stable isotope analysis) of stray or chance finds. The number of new good data points collected over the past decade is, however, limited.

To increase the number of good observations (data points), prospection techniques need to be further developed. The staged approach (geoarchaeological assessment, archaeological sampling, excavation) implemented at Rotterdam-Yangtzehaven was successful, and showed what can be achieved under particular circumstances and within a particular project context. However, in view of the variability in archaeological manifestations of prehistoric behaviour known from the North Sea, as well as the variable character and impacts of economic developments on the seabed, other prospection techniques (including destructive ones) need to be considered and developed.

With respect to the NSPRMF 2009 management agenda, a range of initiatives has been taken. Some initiatives have permitted steps forward, whereas others have made it clear that much remains to be done in order to firmly anchor archaeological interests concerning submerged prehistoric archaeology and landscapes in heritage management policies – and in order to develop regulations as well as strategies.

Collaboration with industry and private collectors has been variably successful. In the context of the Rotterdam-Maasvlakte 2 harbour extension, efforts have led to a strategy that was beneficial for both the scientific community and the economic stakeholders, which involved finding solutions for research opportunities within a highly complex project. Within the same setting, activities focussed on public outreach spurred collaboration among the developer,

scientists, and private collectors. This triggered further initiatives aimed at structural collaboration between scientists and private collectors and the recording of finds. The case study of the Area 240 Palaeolithic hand-axes, as well as that of the Middeldiep Neanderthal skull fragment, however, show that collaboration with industry can easily become disrupted due to conflicting interests.

The systematic recording of finds made by private as well as professional collectors forms an important basis for data sharing. The SPLASHCOS-viewer, which provides basic information about the location and nature of archaeological and palaeontological finds, forms a platform that permits further data sharing. Importantly, the SPLASHCOS-viewer database has been integrated into the EMODnet gateway, thereby making prehistoric cultural heritage a relevant aspect of the marine environment that is made available to a wide array of stakeholders.

Increasing data availability is highly relevant and desirable for the assessment of research potential and threats. Initiatives have been taken to model potential for the presence of prehistoric archaeological remains in the Dutch sector of the continental shelf. These models are coarse-grained due to the relatively low density of geological data on which they are primarily based, and a high degree of expert knowledge is needed to understand and interpret model outcomes. Risk assessments are constrained by the coarseness of the models, which do not permit researchers to evaluate research potential and threats at the scale of individual spatial developments. This limitation hinders pro-active approaches to mitigation, conservation, and designation. The sparseness of good data points makes it difficult, if not impossible, to explicitly make clear which archaeological interests are at stake. As a consequence, geoarchaeological assessments of individual project areas lead to generic designations of zones of potential archaeological interest, without any follow-up to test the validity of the believed potential.

This leads to a paradoxical situation. Many exiting finds continue to be made, and these attract a lot of media attention; they are the hard evidence of human presence in a landscape that has become sea. Public outreach activities have been very successful. But whereas such finds spark the imagination of a broad audience, they have not (yet) led to the establishment of a management approach that demands serious research to move from assessing potential to model testing and observation.

There is no pressing need to define a new set of themes and topics, and priorities have not yet been met to such an extent that no further attention is needed. At the same time, major steps have been taken with regard to some issues, notably data sharing, collaboration with private collectors, and public outreach. These steps are important, and the related efforts should be maintained. In the final section, we present some recommendations, which are meant to serve as guides for further discussion and for targeting actions in the near future. These recommendations are grouped under three headings: contents (the subject of investigation), process (strategies, methods, techniques), and stakeholders (regulations, risk assessment, communication).

Samenvatting

Het *North Sea Prehistory Research and Management Framework (NSPRMF) 2009* was gericht op het beschikbaar krijgen van een agenda voor onderzoek en erfgoedbeheer ten aanzien van verdronken prehistorische vindplaatsen en landschapsresten in de Nederlands-Belgische en Britse delen van de zuidelijke Noordzee. Het kader was op de eerste plaats en vooral gericht op: (1) maximalisatie van archeologische informatie voortkomend uit offshore ontwikkelingen (ruimtelijk, economisch); (2) stimulering van het onderzoek van archeologisch relevante materialen en afzettingen om de stand van kennis te verbreden ten behoeve van archeologische en beheers doelstellingen; (3) stimulering van het publieke begrip en het bewustzijn ten aanzien van het verleden, en het voeden van een gedeeld verantwoordelijkheidsgevoel onder ontwikkelaars, beslissers en wetenschappers; (4) ontwikkeling van een stevig fundament voor erfgoedbeheer ten behoeve van afwegingskaders, advisering en besluitvorming, gestoeld op een internationaal erkende en geaccepteerde waardering van bronnen en een onderzoeksagenda. Met het oog op de enorme hoeveelheid werk dat is uitgevoerd sinds de productie van het NSPRMF 2009 en de doorgaande ontwikkelingen in en rond de Nederlandse sector van het continentaal plat, en om een hernieuwde basis ten behoeve van het erfgoedbeheer te bewerkstelligen, heeft de Rijksdienst voor het Cultureel Erfgoed gevraagd om een synthese en evaluatie van gepubliceerd materiaal en andere spin-off in de context van de oorspronkelijke doelstellingen van het kader. Het onderhavige rapport presenteert de resultaten van deze analyse en is gestructureerd in drie delen: een terugblik op het NSPRMF 2009 (hoofdstuk 2), een evaluatie van de actuele stand van zaken in relatie tot de in het NSPRMF 2009 gestelde prioriteiten (hoofdstukken 3 en 4), en een vooruitblik op kansen, dilemma's en keuzes als basis voor de hernieuwde afstemming of herdefinitie van prioriteiten, evenals een presentatie van in het Nederlandse deel van de Noordzee toepasbare strategieën voor de komende jaren (hoofdstuk 5).

De laatste 10 jaar is veel onderzoek in allerlei vormen uitgevoerd dat relevant is voor de onderzoeksprioriteiten van het NSPRMF 2009. De mate waarin de prioriteiten zijn gehaald is echter variabel.

Inspanningen waren in belangrijke mate gericht op het vergroten van het begrip betreffende geologische factoren die van invloed zijn op de tafonomische geschiedenis van verdronken prehistorische landschappen, evenals die van archeologische en paleontologische vondsten. Diverse studies hebben inzicht gegeven in zeespiegelfluctuatie en paleogeografische veranderingen, factoren die direct relevant zijn voor ons begrip van prehistorische relaties tussen mens en omgeving en socio-culturele processen.
Vooralsnog loopt het verzamelen van goede datapunten achter. Belangrijke resultaten zijn verkregen met betrekking tot het onderzoeken van sites onderwater (Rotterdam-Yangtzehaven), de geologische contextualisering van vondsten met beperkte contextinformatie (Middeldiep, Rotterdam-Maasvlakte 2), evenals de systematische inventarisatie en wetenschappelijke analyse (AMS ^{14}C-datering, stabiele isotopenanalyse) van 'losse' vondsten. Het aantal nieuwe goede datapunten dat in de afgelopen 10 jaar is verzameld, is echter beperkt. Om het aantal goede observaties (datapunten) te laten toenemen is verdere ontwikkeling van prospectietechnieken nodig. De getrapte benadering (geoarcheologische waardering, archeologische bemonstering, opgraving) te Rotterdam-Yangtzehaven is met succes toegepast en laat zien wat bereikt kan worden onder specifieke omstandigheden binnen een bepaalde projectcontext. Echter, met het oog op de variabiliteit in archeologische verschijningsvormen van prehistorisch menselijk gedrag zoals die uit de Noordzee bekend zijn, evenals het variabele karakter en de variabele invloed van economische activiteiten op de zeebodem, zullen andere prospectiemethoden (inclusief destructieve) overwogen en ontwikkeld moeten worden.

Voor wat betreft de NSPRMF 2009 managementagenda is een reeks initiatieven genomen. Sommige initiatieven hebben het mogelijk gemaakt om stappen vooruit te zetten, terwijl andere duidelijk maken dat er nog veel moet gebeuren om archeologische belangen betreffende verdronken prehistorische archeologie en landschappen stevig verankerd te krijgen in erfgoedbeleid – en om regulering en strategieën te bewerkstelligen.

Samenwerking met de industrie/ontwikkelaars en private verzamelaars is wisselend succesvol geweest. In de context van de havenuitbreiding van Rotterdam-Maasvlakte 2 hebben inspanningen geleid tot een strategie die voordelig was voor zowel de wetenschappelijke gemeenschap als de economische belanghebbenden, waarbij het er om ging dat oplossingen gevonden konden worden voor onderzoekkansen binnen een uitermate complex project. In dezelfde context bewerkstelligden publieksgerichte activiteiten samenwerking tussen de ontwikkelaar, wetenschappers en private verzamelaars. Dit maakte nieuwe initiatieven los die waren gericht op structurele samenwerking tussen wetenschappers en private verzamelaars, en de registratie van vondsten. De casussen van de paleolithische vuistbijlen uit Area 240 en van het Neanderthaler schedelfragment uit het Middeldiep maken echter duidelijk dat de samenwerking met de industrie makkelijk verstoord raakt vanwege conflicterende belangen.
De systematische registratie van vondsten gedaan door private en professionele verzamelaars vormt een belangrijke basis voor het delen van gegevens. De SPLASHCOS-viewer maakt basale informatie beschikbaar over de locatie en aard van archeologische en paleontologische vondsten, en biedt een platform voor het verder delen van gegevens. Belangrijk is dat de SPLASHCOS-viewer database is geïntegreerd in de EMODnet gateway, waarmee prehistorisch cultureel erfgoed een relevant aspect van de mariene omgeving is geworden en beschikbaar is gemaakt voor een brede waaier belanghebbenden.
Het vergroten van gegevensbeschikbaarheid is uitermate relevant en wenselijk voor de inschatting van onderzoekpotentieel en bedreigingen. Er zijn initiatieven genomen om de potentiële aanwezigheid van prehistorische archeologische resten in het Nederlandse deel van het continentaal plat te modelleren. De modellen zijn grofkorrelig vanwege de relatief lage dichtheid aan geologische gegevens waarop ze primair zijn gebaseerd, en gebruikers moeten over een hoge mate van expertise beschikken om de modeluitkomsten te kunnen begrijpen en interpreteren.

De inschatting van risico's wordt beperkt door de grofkorreligheid van de modellen, wat het onderzoekers onmogelijk maakt om het onderzoekspotentieel en bedreigingen in te schatten op de schaal van individuele ruimtelijke ontwikkelingen. De schaarsheid aan goede datapunten maakt het moeilijk, zo niet onmogelijk, om expliciet te maken welke archeologische belangen op het spel staan. Dientengevolge leiden geoarcheologische waarderingen van individuele projectgebieden tot generieke aanwijzing van zones van potentiële archeologische betekenis, zonder daarop volgende acties om het veronderstelde potentieel te testen.
Dit leidt tot een paradoxale situatie. Er worden doorlopend bijzondere vondsten gedaan die veel aandacht van de media trekken; ze zijn het harde bewijs van menselijke aanwezigheid in een landschap dat zee geworden is. Publieksactiviteiten zijn erg succesvol geweest. Maar daar waar zulke vondsten de verbeelding van een breed publiek losmaken, hebben ze (nog) niet geleid tot een managementbenadering die verlangt dat serieus onderzoek zich verplaatst van verwachting naar het testen van modellen en observatie.

Er is geen dringende noodzaak om een nieuwe set thema's en onderwerpen te definiëren, en prioriteiten zijn nog niet op een dusdanig niveau behaald dat deze geen verdere aandacht behoeven. Tegelijkertijd moet worden geconstateerd dat ten aanzien van sommige aspecten belangrijke stappen zijn gezet, vooral op het gebied van gegevensdeling, samenwerking met private verzamelaars en publieksbereik. Deze stappen zijn belangrijk en de daaraan gerelateerde inspanningen moeten worden voortgezet. In het laatste deel presenteren we een aantal aanbevelingen die dienen als richtinggevende lijnen voor verdere discussie en voor het bepalen van actiepunten in de nabije toekomst. De aanbevelingen zijn gegroepeerd onder drie koppen: inhoud (het onderwerp van onderzoek), proces (strategieën, methoden, technieken), en belanghebbenden (regulering, risicoschatting, communicatie).

1 Introduction

The North Sea is an internationally recognised part of the continental shelf that is of paramount economic value and ecological importance. The economic value relates to the exploitation of marine food resources (fish, shellfish, algae), aggregate dredging (sand, gravel), oil and gas recovery, sustainable energy production (wind farms, hydraulic generators), and infrastructural works (harbours, navigation channels, cables, pipelines). In one way or another, but to a variable extent, these activities all entail disturbance of the seabed. In addition, natural processes (sea currents, wave action) continuously alter the sea floor topography due to erosion and sedimentation. This combination of factors significantly impacts the various ecosystems found in the very same waters and has led environmentalists to try to influence politicians to take measures to mitigate the negative effects of this disturbance, and to focus on sustainable solutions. The legislative basis for the use of the sea and its resources was laid down in 1982, in the *United Nations Convention on the Law of the Sea* (UNCLOS).

Underwater cultural heritage received only marginal attention in the 1982 convention, despite its recognition as an asset of the sea floor,. A supplement, the *Convention for the Protection of Underwater Cultural Heritage,* was drafted in 2001 and came into force in 2009. In that same year, the cultural heritage agency of the Netherlands (Rijksdienst voor het Cultureel Erfgoed) and English Heritage (now Historic England) jointly published the *North Sea Prehistory Research and Management Framework (NSPRMF) 2009*.[1] The NSPRMF 2009 was the outcome of an expert meeting, held in 2008 in Amersfoort, which brought together researchers (archaeologists, palaeontologists, earth scientists) and heritage professionals from the Netherlands and the United Kingdom. Based on expert knowledge and scientific results, the NSPRMF 2009 aimed to '… improve recognition of the international significance of the southern North Sea Basin for early humans in the landscape. It is meant to encourage carefully developed and targeted research in the context of development-led and research-driven projects and programmes. It is also intended to underpin the development of conservation strategies adapted to the specific characteristics of this record.'.[2]

The framework first and foremost focussed on: (1) maximisation of archaeological information arising from offshore developments (spatial, economic); (2) stimulation of the study of archaeologically relevant materials and deposits to broaden the knowledge base for archaeological and management purposes; (3) stimulation of public understanding and awareness of the past, and fostering of a shared sense of responsibility among developers, decision makers, and scientists; (4) development of a firm basis for heritage management judgement, consultancy, and decision-making, notably an internationally recognised and scientifically accepted set of resource assessments and research agenda.[3]

Today, 10 years after that expert meeting in Amersfoort, much has been undertaken and achieved. Several conference sessions in 2008 triggered the formation of the so-called Deukalion planning group – comprising sixteen experts from eight European countries – to draft the outlines of a multidisciplinary project. In 2009, this work resulted in the EU-COST (European Cooperation in Science and Technology) programme *Submerged Prehistoric Archaeology and Landscapes of the Continental Shelf* (SPLASHCOS), led by Geoff Bailey (University of York).[4] Many books, papers, reports, and datasets have been produced, providing a wealth of information, much of which either applies directly to the North Sea or is of significance for our understanding of submerged prehistoric archaeology and landscapes in the North Sea.[5] A number of strategic documents and papers have been published as well, in the form of a research agenda or a discussion or review paper.[6] In addition, targeted research has been conducted offshore, aimed at the investigation of specific sites[7] and find zones[8] and the contextualisation of stray finds.[9] Newly started research projects have come up with spectacular and unexpected results.[10] Finally, there has been a combined effort to document and analyse the many stray finds.[11] These undertakings underline the enormous potential of the seabed on this part of the continental shelf. More importantly, new initiatives have demonstrated that carefully planned and informed research strategies result in valuable new data points, which, in turn, permit a better understanding of the archaeological record, not

1 Peeters, Murphy & Flemming 2009.
2 Peeters, Murphy & Flemming 2009, 8.
3 Ibid.
4 Bailey & Sakellariou 2017, xii.
5 E.g. Benjamin *et al.* 2011; Evans, Flatman & Flemming 2014; Peeters & Cohen 2014; Bailey, Harff & Sakellariou 2017; Flemming *et al.* 2017; Bailey *et al.* in prep.
6 E.g. Ransley *et al.* 2013; Flemming *et al.* 2014; Sturt *et al.* 2018.
7 Momber *et al.* 2011; Moree & Sier 2014, 2015.
8 E.g. Wessex Archaeology 2011; Kuitems *et al.* 2014, 2015.
9 E.g. Hublin 2009; Hijma *et al.* 2012.
10 For example, the large, European Research Council-funded Lost Frontiers Project (Gaffney *et al.* 2017); the Innovation by Science and Technology (IWT)-funded Drowned Landscapes of the Belgian Continental Shelf PhD project undertaken at Ghent University and the Flanders Marine Institute (De Clercq 2018); and a project focussed on post-Last Glacial Maximum sea-level rise in the North Sea, conducted by Deltares, TNO-Geological Survey, Utrecht University, Royal Netherlands Institute for Sea Research, and University of Leeds.
11 The informal collaboration of members of the Rijksdienst voor het Cultureel Erfgoed, the Rijksmuseum van Oudheden, the archaeology service of the municipality of Rotterdam (Archeologie Rotterdam), and the Werkgroep Steentijd Noordzee/ Doggerland Research Group had provided overviews of these finds, as well as studies on such aspects as isotope and aDNA potential. This collaboration also led to the creation of a coherent network of amateur archaeologists/palaeontologists and beachcombers and to a re-evaluation of the concept of 'stray finds'.

only offshore, but also onshore. Importantly, the (international) exchange of expertise continues to feed into the development and definition of new management targets[12] and plays a role in public outreach and the dialogue with industry.[13]

In view of the vast body of work that has been carried out since the production of the NSPRMF 2009 and the ongoing developments in and around the Dutch sector of the continental shelf, and in order to set a fresh baseline for management purposes for the coming years, the cultural heritage agency of the Netherlands has requested a synthesis and evaluation of published material and other spin-offs in the context of the initial aims of this framework. The present report provides the outcome of this analysis.
The central question in this report is what has been achieved in the past decade in terms of defined themes, topics, and priorities. The synthesis/evaluation also integrates and reflects upon other relevant strategic frameworks.[14]

This will feed into a (re)defined set of aspects that require attention in the (near) future in the context of, on the one hand, development-driven research in the Dutch North Sea waters and, on the other, heritage management practices and frameworks in the Netherlands.
In order to cover the full range of aspects (archaeology, landscape, geology, management, public outreach) addressed in the NSPRMF 2009, all relevant published work (books, journal papers, professional reports) has been taken in consideration for the current report, as have materials circulated via websites, newsletters, and media coverage.

The present report is structured into three parts: a look back at the NSPRMF 2009 (chapter 2), an evaluation of the current state of affairs in relation to the priorities set in the NSPRMF 2009 (chapters 3 and 4), and a look forward to opportunities, dilemmas, and choices, in order to retune or redefine priorities and present possible strategies for the coming years (chapter 5).

[12] Workshops commissioned by English Heritage were hosted at Southampton; these were dedicated to the social dimension of submerged prehistoric landscapes and the possibilities (2013) and role (2014) of predictive modelling.

[13] Erkens *et al*. 2014; Vonhögen-Peeters, Van Heteren & Peeters 2016; Vonhögen-Peeters, Maljers & Peeters in prep. For an overview of public outreach activities, see table 5.

[14] Position Paper 21 of the European Marine Board (Flemming *et al*. 2014); A Maritime Archaeological Research Agenda for England (Ransley *et al*. 2013).

2 NSPRMF 2009: themes, topics, and priorities

2.1 Introduction

The *North Sea Prehistory Research and Management Framework (NSPRMF) 2009* set out to provide an agenda for the research and heritage management of submerged archaeological sites and relict landscapes in the southern North Sea (fig. 1). The framework comprises four sections, which are briefly summarised below. Following this summary, each section is discussed in further detail in order to provide a framework for synthesis and evaluation. This chapter thus describes the situation of about a decade ago.

2.2 Summary of the four sections

Section 1: General outline and context
This section (1) defines the chronological and geographical scope of the framework (the time period prior to the 'Holocene inundation of what are today the shallowest parts of the North Sea between the British Isles and the Netherlands coastlines',[15] notably the Dutch and Belgian sectors and the adjacent part of the British sector of the Continental Shelf, extending to the Straits of Dover and the English Channel); (2) defines the scale of scientific interest (first and foremost at the landscape level, and including any type of information – not just 'sites' – providing evidence for human activity/presence, even including 'empty' space); (3) characterises threats and opportunities in the context of spatial developments (economic activities and climate-related impacts on sediment dynamics and coastal change, data collection to fill fundamental knowledge gaps so as to provide a sensible basis for decision-making); and (4) discusses management embedding (political and legislative context of heritage management at national and international scales).

Section 2: Resource assessment
This section focussed on the state of knowledge (anno 2008) concerning palaeolandscapes and prehistoric archaeology, so as to provide a baseline for the identification of gaps in our knowledge and to define research potential. The survey covered four aspects: stratigraphy and chronological frameworks, landscape surfaces, palaeontological and palaeobotanical assemblages, and archaeological assemblages.

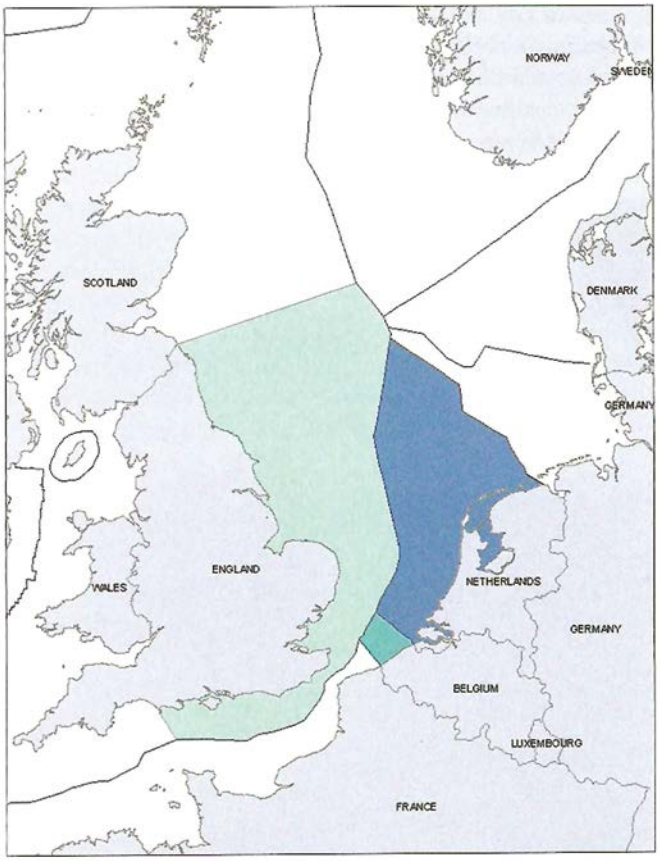

Fig 1 Geographical scope of the NSPRMF 2009, comprising the Belgian and Dutch section of the Gontinental Shelf areas and adjacent part of the UK section (after Peeters, Murphy & Flemming 2009, Fig. 2).

Section 3: Research agenda and strategies
Based on the resource assessment, this section provided a thematically structured agenda for research on a variety of topics identified as being of potential interest in the context of the southern North Sea. An outline of themes and topics was followed by a note on research strategies (targeted research in the context of spatial developments, curiosity-driven research) and the identification of priorities (better understanding of palaeogeography, improved chronology, the collection of good data points, the development of prospection techniques).

Section 4: Resource management agenda and strategies
Focussed on the research agenda and strategies, and in recognition of the difficulties that are

[15] Peeters, Murphy & Flemming 2009, 9.

inherent to the specific nature of prehistoric landscapes and archaeology, this section explored the main issues of heritage management. An outline of themes and topics was followed by a note on strategies (tuning objectives of heritage management and scientific research, creating conditions to support the development and implementation of appropriate research and management strategies) and priorities (collaboration with industry and private collectors; data sharing on and spatial definition of research potential and threats; mitigation, conservation, and designation).

2.3 NSPRMF 2009: context

With regard to context, it is important to stress that the geographical scope is of course arbitrary. The choices made were primarily driven by practical considerations, notably the availability of data and the perceived need among Dutch and British researchers and heritage professionals to join forces. At the time of the Amersfoort expert meeting and publication of the NSPRMF 2009, the majority of archaeological work focussed on the southern North Sea, both in terms of research (surveys at Pakefield and Happisburgh, mapping of Doggerland using reprocessed legacy seismics, collection of palaeontological and archaeological material)[16] and resource management (aggregate dredging, the Maasvlakte 2 extension to Rotterdam harbour),[17] and underwater excavations at Bouldnor Cliff (English Channel).[18] In addition, much geological work had been done and was being done on sea-level rise, chronology, and palaeogeography.[19] Furthermore, the need for research and management agendas (or frameworks) and the development of management tools was being recognised on both sides of the southern North Sea, and the use of these agendas and tools had, to some extent, become part of archaeological practice.[20]

The key question that drove the development of the NSPRMF 2009 was how to deal with the pressure on the submerged – and evidently preserved – (pre)historic environment from ever-increasing economic activity in the southern North Sea. The enormous scale of the fishing industry, aggregate extraction, energy resource extraction, offshore and coastal construction works, and coastal risk-management schemes meant that it was crystal clear that action was needed if one were to prevent, at least to some extent, the loss of valuable information. However, there was a general lack of scientific knowledge that might serve to underpin decision-making, and hence there was also an uncomfortable feeling, on the part of researchers that they risked making bad mistakes. At the same time, researchers perceived a pressing need to obtain good data points (fig. 2). Adding new data points to the record in such a situation inevitably implies disturbance in many cases. Therefore, it was stated that 'the risk of damaging in situ contexts through properly resourced scientific research must surely be accepted in the interest of creating a baseline for better informed decision-making later'.[21]

Taking such a position is clearly the result of a deliberate choice, and in the present context it is also the result of mutually felt responsibility. This feeling of responsibility, however, does not necessarily line up with regulations and legislation at the national and international levels. The offshore environment – territorial waters and the Continental Shelf – constitutes a highly complex setting. The cross-border approach taken in the NSPRMF 2009 meant having to deal not just with differences in national legislation, policies, and, indeed, heritage management philosophies, but also with international conventions that apply to areas beyond national jurisdiction (*Convention for the Protection of Underwater Cultural Heritage*, *European Landscape Convention*). Continuous dialogue between national and international bodies is necessary in order to embed practical approaches in this web of legislation, policies, and regulations. However, the cultural heritage sector cannot simply draw its own plans, because many other interests have to be taken in account, particularly where it concerns the natural environment.

2.4 NSPRMF 2009: resource assessment

In order to set a baseline for the 2009 research and management agenda, it was necessary to make an assessment of the state of knowledge,

16 Glimmerveen *et al.* 2004; Verhart 2004; Parfitt *et al.* 2005; Bell *et al.* 2006; Glimmerveen, Mol & Van der Plicht 2006; Mol *et al.* 2006; Bell 2007; Gaffney, Thomson & Fitch 2007; Ashton *et al.* 2014.

17 Wenban-Smith 2003; Maarleveld & Peeters 2004; Fitch, Thomson & Gaffney 2005; Bell *et al.* 2006; Ward & Larcombe 2008.

18 Momber *et al.* 2011.

19 Rieu *et al.* 2005; Weerts *et al.* 2005; Schokker *et al.* 2005; Shennan *et al.* 2006; Ward, Larcombe & Lillie 2006; Gaffney, Thomson & Fitch 2007; Gupta *et al.* 2007; Vink *et al.* 2007; Gibbard & Cohen 2008; Hazell 2008; Weniger *et al.* 2008.

20 Glazebrook 1997; Williams & Brown 1997; Brown & Glazebrook 2000; Deeben, Hallewas & Maarleveld 2002; Flemming 2002, 2004; Rijksdienst voor het Oudheidkundig Bodemonderzoek 2006; Peeters 2007; Pettitt, Gamble & Last 2008. For an overview of archaeological research frameworks in the United Kingdom see https://citizan.org.uk/resources/archaeological-research-frameworks/.

21 Peeters, Murphy & Flemming 2009, 11.

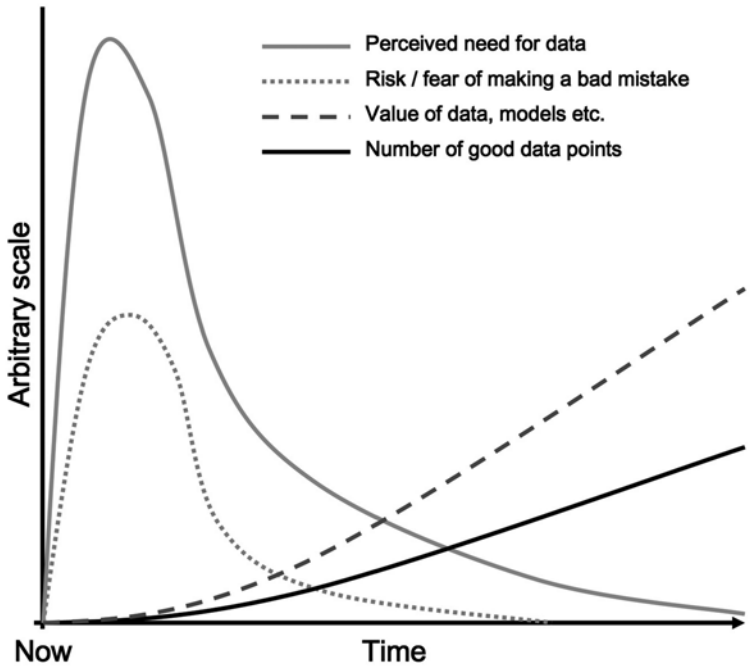

Fig 2 Schematic representation of the relationship between scientific knowledge and decision making (after Peeters, Murphy & Flemming 2009, Fig. 4).

i.e. of the (potential) informative value of the available data. To structure this assessment, four specific aspects (see below) were addressed to provide the building blocks for a sensible approach to the prehistoric archaeology of the southern North Sea.

Stratigraphic and chronological frameworks
Central to this aspect are the development of an understanding of archaeological manifestations of human behaviour in the landscape in terms of formation processes and environmental context. An understanding of the genesis and provenance of deposits provides essential information about (changing) landscape conditions in time and space, which affect, one the one hand, human behaviour and, on the other, the preservation context. However straightforward this may seem, the development of solid reference frameworks is not without problems, due to the necessity of correlating highly diverse and localised phenomena over vast spans of time and space. Even though there is now the possibility to obtain 'absolute' dates on deposits at purposely sampled point localities, chronologies remain spatially and temporally coarse, especially for the period before the Holocene transgression (>10,000 years) and for the period beyond the limits of the radiocarbon dating technique (>35,000 years). A second problem concerns the correlation of lithostratigraphic systems, which differ between nations and have been subject to revision.
A strict lithostratigraphic approach independent of age permits an understanding of formation processes and a translation of geological map units to palaeolandscape situations. Nonetheless, to understand archaeological patterning, there is a need for reliable chronological frameworks in addition to these lithostratigraphic mappings. Several options are at hand. These include direct absolute dating of sediments and/or non-reworked fossil components (optically stimulated luminescence [OSL], accelerator mass spectrometry [AMS] ^{14}C), direct dating of ex situ components (AMS ^{14}C), indirect 'absolute' dating based on mean sea-level reconstructions (time-depth correlation), and indirect relative dating based on lithostratigraphy and interpreted palaeogeographic meaning (older/younger than). In addition, indirect typological dating of archaeological finds provides clues as to the age of the sediments from which these derive.

Landscape surfaces
Palaeolandscape mapping is considered to be highly important for the archaeological

understanding of prehistoric land use patterns. The combination of sea-level data, on the one hand, and independent dates and sediment-source information, on the other, provides possibilities for modelling landscape evolution and, in turn, provides a context in which archaeological data can be interpreted. In addition, insight can be gained into the survival of ancient land surfaces, which is important for significance assessment of finds 'lacking context', i.e. those with unknown taphonomy, mostly dredged up during fishing activity or found on beaches following beach replenishment via sea-bed sand extraction. Such information is equally important for management purposes, notably for the development of models of archaeological potential, as well as the mapping of threats. Furthermore, dynamic palaeolandscape models, and visualisations thereof, can play an important role in public outreach. The possibilities for landscape mapping have significantly increased due to the availability of improved analytical techniques for (2D and 3D) seismic data, thus permitting a better understanding of the stratigraphic characteristics of the seabed, the identification of landscape elements (geomorphological entities), and detailed visualisation.[22] Combined with borehole data, these techniques have the potential to develop increasingly detailed maps and map time series, which are needed for targeted research.

Palaeontological and palaeobotanical assemblages

The vast majority of finds from the southern North Sea consists of fossil bones dredged up from the sea floor during fishing activity and from greater depths in the seabed during aggregate mining, dredging, and replenishment activities. Palaeobotanical material is also known from corings, dredged-up lumps of peat and tree stumps, as well as in situ tree stumps and organic layers in the tidal zone. In most cases, no information about the original sedimentary context of these palaeontological and botanical finds has been collected, making it difficult to evaluate their representativeness in terms of what was originally present or in terms of temporal integrity. Contextualisation of palaeontological and palaeobotanical material is therefore of importance. What is of importance as well is to realise that finds also have 'intrinsic' value; that is to say, they bear information that may have scientific value even in the absence of elaborate contextual information.[23] Systematic AMS ^{14}C dating of bone finds that have been identified to species may reveal patterns in their age distribution that can underpin inferences drawn from lithological data and the projection of insights obtained on the surrounding land. They may also reveal the presence or absence of humans at different times.[24] Palaeovegetation data from offshore locations are still scarce compared with those from terrestrial locations, but palynological analysis (in the form of pollen diagrams showing local and regional vegetation developments) can be used to cross-check and help tune models of palaeolandscape conditions that would otherwise be based on sea-floor relief and lithology and analogies.[25] Microfossils (pollen, diatoms, dinoflagellates, foraminifera) also inform about landscape inundation.[26] Stable isotope data can be informative about diet, as can aDNA about, for instance, geographical species differentiation at the population level. Quantitative information on taxonomy and age may provide insight into subregional variability in species and age composition.

Archaeological assemblages

Much of what has been said above about palaeontological and palaeobotanical assemblages also applies to archaeological assemblages, notably with regard to issues of context and dating. Of course, artefacts made out of organic materials (e.g. wood, bone, antler) can be dated by means of AMS ^{14}C analysis, as can human remains. In contrast, in the absence of lithostratigraphic information, the dating of inorganic items (mostly lithics) depends on coarse typological and/or technological chronological schemes. Chronological anchoring of archaeological finds is, however, crucial for the modelling of (re)colonisation patterns in connection to Glacial–Interglacial cycles and palaeogeographical reshaping. In contrast to palaeontological assemblages, due to their generally small size, the unfamiliarity of collectors with certain types of objects, as well as differential preservation, the body of archaeological finds from the southern North Sea is too numerically small and biased for researchers to attempt any form of quantitative analysis.[27] However, like palaeontological and

22 Gaffney, Thomson & Fitch 2007.
23 Van Kolfschoten & Van Essen 2004; Van Kolfschoten 2006.
24 Glimmerveen *et al.* 2004; Glimmerveen, Mol & Van der Plicht 2006; Mol *et al.* 2006.
25 Wolters, Zeiler & Bungenstock 2010; Krüger *et al.* 2017.
26 Vink *et al.* 2007; Sturt, Garrow & Bradley 2013.
27 Today, many more archaeological finds are known, and especially the number (over 1000) of barbed points permits a quantitative approach (Spithoven 2015).

palaeobotanical finds, archaeological finds bear intrinsic information and can potentially add to debates about occupation histories,[28] as well as the exploitation of coastal zones and the socio-cultural meaning of the marine environment (e.g. through stable isotope analysis).[29] Evidence for pre-/post-mortem pathologies can provide insights into issues of health and social relationships.[30] Hence, there is much potential, certainly in view of the good preservation of many finds.

2.5 NSPRMF 2009: research agenda, strategies, and priorities

The assessment of resources formed the basis for the scientific agenda, which identifies a number of themes and topics that are considered to be of importance, that is to say, for which research relating to the southern North Sea can be informative and provide meaningful data. These themes and topics are summarised in table 1.

The strategic approach to investigating these themes and topics involves problem-oriented or targeted research in either a development-driven or a science-driven context. In a development-driven context, scientific choices are required to remain confined to the conditions agreed upon with the developer. These conditions are not necessarily restricted to constraints of time and money; they can also relate to safety and to technical and logistical feasibility. Research initiated by academia is science-driven, but it, too, has to meet a number of preconditions with regards to e.g. financing, the availability of equipment, and ship-time (e.g. on research vessels) and therefore often consists of research consortia.

From the perspective of research, an improved understanding of palaeogeography and chronology, the collection of good data points, and the development of prospection techniques have been identified as priorities – on the one hand because palaeogeographic models and chronological frameworks provide an important context for reaching a better understanding of the significance of countless

Table 1 Research themes and topics from the NSPRMF 2009 (Peeters, Murphy & Flemming 2009). Numbering adheres to the original document.*

Theme	Topics
A. Stratigraphic and chronological frameworks	A.1: Lithostratigraphic classification and chronological anchoring A.2: Sea level change and glacio-isostacy A.3: Survival of deposits of archaeological significance A.4: Biostratigraphies and absolute dating
B. Palaeogeography and environment	B.1: Middle/Late Pleistocene reshaping of topography and river drainage B.2: Development of the Weichselian/Devensian landscape B.3: Palaeogeographic evolution after the Last Glacial Maximum (LGM) B.4: Quaternary palaeoecology
C. Global perspectives on intercontinental hominin dispersals	C.1: North Sea coastal dynamics and human uses of the coastal zone C.2: Pleistocene North Sea level oscillations and population of islands
D. Pleistocene hominin colonisations of northern Europe	D.1: Early human exploitation strategies in changing environments D.2: Natural barriers for hominin expansion
E. Reoccupation of northern Europe after the Last Glacial Maximum (LGM)	E.1: Post-LGM occupation flux E.2: Occupation strategies
F. Post-glacial land use dynamics in the context of a changing landscape	F.1: Changing landscape structure F.2: Behavioural diversity among hunter-gatherers F.3: Maritime archaeologies of the North Sea
G. Representation of prehistoric hunter-gatherer communities and lifeways	G.1: Spatial perspectives on North Sea palaeolandscapes G.2: The distributional nature of early hominin communities G.3: Enculturated hunter-gatherer landscapes

* Despite the fact that theme G primarily focusses on post-LGM hunter-gatherers, topic G.2 was broadly defined, and of equal relevance to theme D.

[28] See e.g. Hijma *et al.* 2012; Peeters & Momber 2014; Roebroeks 2014; Momber & Peeters 2017.
[29] Van der Plicht *et al.* 2016.
[30] Hublin *et al.* 2009; Amkreutz *et al.* 2018a, 2018b.

palaeontological, palaeobotanical, and archaeological finds, and on the other hand because of the necessity to extend the record of reliable (i.e. contextualised) observations.

2.6 NSPRMF 2009: management agenda, strategies, and priorities

In addition to the research agenda, an agenda for management purposes was set. It, too, identified a number of relevant themes and topics (table 2), taking into consideration the defined context of the framework, as well as the resource assessment.

The management agenda first and foremost focussed on heritage professionals who are the first to deal with economical stakeholders active in the southern North Sea. This particular context involves a complex legislative and regulatory setting, at the national and international levels, that has to be taken in consideration by both heritage managers and economic stakeholders. In order to deal with (often) opposing interests, it is necessary to have clear definitions and to look into effective approaches to protection and preservation. However, several topics also require research and agreements on how to treat, store, and share data. Importantly, public outreach was explicitly included in the 2009 agenda, touching upon topics believed to be relevant to modern-day society.

In order to reach these goals, it was deemed necessary to focus on tuning the objectives of heritage management and scientific research, as well as creating conditions to support the development and implementation of appropriate research and management strategies. Several priorities were identified, notably collaboration with industry and private collectors; data sharing; the spatial definition of research potential and threats; as well as approaches to mitigation, conservation, and designation.

Table 2 Management themes and topics from the NSPRMF 2009 (Peeters, Murphy & Flemming 2009). Numbering adheres to the original document.

Theme	Topics
H. Legislation and preservation	H.1: Defining prehistoric cultural heritage H.2: Common ground for the protection of the historic and natural environment H.3: Conservation of submerged prehistoric landscapes in a dynamic environment
I. Assessment and data sharing	I.1: Research potential and threat mapping I.2: Surveying I.3: Data sharing and find reporting I.4: Co-operation
J. Public outreach	J.1: Changing worlds J.2: 'Them' and 'Us' | 'Nature' and 'Culture'

3 Research and knowledge gain

3.1 Introduction

As outlined in the previous chapters, as a strategic document, the NSPRMF 2009 had clear goals with regard to research: to stimulate effective use of archaeological information arising from offshore developments for research and management and to stimulate the study of archaeologically relevant information sources to broaden the scientific basis for research and management. The scientific backing of the 2009 framework is found in a series of papers published in the period from *c.* 2004 (publication of results from an expert meeting held in London 2003)[31] to 2014 (special issue of the *Netherlands Journal of Geosciences – Geologie en Mijnbouw*).[32]

In this chapter we set out to explore what has been achieved with respect to the NSPRMF 2009 research agenda (summarised in table 1). For the purpose of the present evaluation, we will look at synthetic overviews; studies focussed on the information value of stray finds (i.e. finds with limited contextual information); as well as targeted research focussed on archaeology and palaeontology, sea-level fluctuations, and geophysical mapping of palaeolandscape elements. The emphasis is on work relating to the Dutch sector of the North Sea, but a 'cross-border' perspective will be taken wherever this is deemed useful or necessary. Table 3 summarises the main research activities and achievements with respect to the themes and topics, and provides an indication of their implications for research.[33] Some work was directly inspired by the NSPRMF 2009, while other work was more loosely related to the framework; both categories are included in the table. In the following sections, this will be expanded upon in connection to the (closely related) priorities set in the NSPRMF 2009.

3.2 Priority: an improved understanding of palaeogeography and chronology

Considerable work has been done with respect to the interpretation of geological data for the purposes of palaeogeographical reconstruction and the establishment of chronological frameworks. For a large part, this work involves synthesising analyses of existing data and mapping (bathymetry, geology), complemented by newly obtained data and maps.[34] All this is highly relevant to the NSPRMF 2009 for several reasons: it translates generic offshore geological mapping (from bathymetry, sea-floor grab samples, borehole samples, seismics) to past landscape conditions, it forecasts the degree of preservation and the taphonomy of sea-floor sites, and it helps to contextualise the many stray finds that have come from the North Sea bed and hence to increase the informative value of these. In addition, for series of time frames, it provides an 'abiotic landscape canvas' that can be used in the modelling of dynamic relationships between landscape and human behaviour at various scales in time and space.

In order to understand landscape dynamics and the preservation of deposits in the southern North Sea on timescales of tens of thousands of years, it is essential to have a solid understanding of the position of the main river systems and of sea-level oscillations. River systems define corridors of significant sediment transport and reworking, while sea-level oscillations strongly influence not only the current size of the southern North Sea but also preservation and erosion. River systems are mapped using seismic and borehole data, while time control is mainly achieved through OSL and AMS ^{14}C dating. Sea-level reconstructions for periods younger than *c.* 50,000 years ago rely heavily on AMS ^{14}C dating of peat samples that can be either directly linked to a past sea level (i.e. a sea-level index point) or used to define an upper limit for sea level. By combining these reconstructions with models of glacio-isostatic adjustments and, preferably, accounting for erosion and sedimentation, it is possible to determine inundation rates of the southern North Sea. Archaeology-driven research conducted in the context of the Maasvlakte 2 harbour extension has increased the density of data points concerning Early to Middle Holocene relative sea-level rise in the southern North Sea[35] for the critical time period around 8,500 years ago that resulted in the drowning of the near-offshore. Further offshore work spawned by British wind farm activities in the Dogger Bank area, as well as research focusing on glaciological dynamics (the NERC-funded

31 Flemming 2004.

32 Glimmerveen *et al.* 2004, 2006; Van Kolfschoten & Van Essen 2004; Mol *et al.* 2006; Hijma *et al.* 2012; Cohen, Gibbard & Weerts 2014; Peeters & Cohen 2014; Peeters & Momber 2014; Roebroeks 2014; Van Heteren *et al.* 2014.

33 Note that table 1 contains references that are not necessarily repeated in the text.

34 Hijma *et al.* 2012; Cohen *et al.* 2014; De Clercq 2018.

35 Vos *et al.* 2015; Hijma & Cohen, in press.

Table 3 Main results of ten years of research.

Themes and topics	Activity	Achievement	Implication	Reference
Theme A: Stratigraphic and chronological frameworks				
A.1: Lithostratigraphic classification and chronological anchoring	Geological assessment of near-coast lithostratigraphy	Correlation of offshore units with onshore classification and chronology	Potential origin and dating of Middle Palaeolithic finds and Neanderthal skull fragment	Hijma *et al*. 2012
	Desktop modelling and synthetic study	Effect of lithology on coastal morphodynamics	Understanding of offshore lithological build-up	Hijma 2017
A.2: Sea-level change and glacio-isostacy	Rotterdam-Maasvlakte 2 targeted sampling sand extraction pits	Identification of Weichselian North Sea high stand	Major sea-level fluctuation during the Weichselian	Kuitems *et al*. 2015
	Desktop modelling	GIA-modelled transgression of the southern North Sea during the Early Holocene	Understanding of ununddation rates and shifting coastlines	Sturt, Garrow & Bradley 2013; Cohen *et al*. 2017
	Synthesis of existing sea-level data	Sea-level database of the Rhine-Meuse valley	First sea-level curve for the transgression of the Rhine-Meuse-Thames valley from Dover to Rotterdam	Hijma & Cohen (in prep.)
A.3: Survival of deposits of archaeological significance	Rotterdam-Yangtze harbour seismic mapping and coring	Erosion of higher parts of Early/Mid-Holocene river dunes and intact sequences on slopes and adjacent floodplains	High potential for archaeological research	Vos & Cohen 2015
	Synthesis of seismic and borehole data offshore Zuid-Holland	Insight into transgression of this part of the North Sea.	Preserved aeolian dune deposits offshore Scheveningen	Hijma *et al*., 2010
A.4: Lithostratigraphies and absolute dating	Rotterdam-Maasvlakte 2 targeted sampling sand extraction pits	Identification of Weichselian North Sea high stand	Major sea-level fluctuation during the Weichselian	Kuitems *et al*. 2015
Theme B: Palaeogeography and environment				
B.1: Middle/Late Pleistocene reshaping of topography and river drainage	Synthetic study	Reconstruction of proglacial lake extents in the southern North Sea	–	Gibbard & Cohen 2015
B.2: Development of the Weichselian/Devensian landscape	Synthetic study	Palaeogeographic reconstructions of the southern North Sea for the Weichselian/Devensian (Early Glacial and Pleniglacial)	–	Hijma *et al*. 2012
B.3: Palaeogeographic evolution after the Last Glacial Maximum (LGM)	Desktop modelling	GIA-modelled transgression of the southern North Sea during the Early Holocene	Understanding of ununddation rates and shifting coastlines	Sturt, Garrow & Bradley 2013; Cohen *et al*. 2017
B.4: Quaternary palaeoecology	–			
Theme C: Global perspectives on intercontinental hominin dispersal				
C.1: North Sea coastal dynamics and human uses of the coastal zone	Synthetic study	Theoretical outline of the role of coasts in early hominin dispersals	Significance of submerged coastal context for the understanding of occupation patterns	Cohen *et al*. 2012
C.2: Pleistocene North Sea level oscillations and population of islands	–	–	–	–
Theme D: Pleistocene hominin colonisations of northern Europe				
D.1: Early human exploitation strategies in changing environments	Synthetic study	Theoretical outline of the role of coasts in early hominin dispersals	Significance of submerged coastal context for the understanding of occupation patterns	Cohen *et al*. 2012
D.2: Natural barriers for hominin expansion	Synthetic study	Theoretical outline of the role of coasts in early hominin dispersals	Significance of submerged coastal context for the understanding of occupation patterns	Cohen *et al*. 2012
	Geological assessment of near-coast lithostratigraphy	Correlation of offshore units with onshore classification and chronology	Potential origin and dating of Middle Palaeolithic finds and Neanderthal skull fragment	Hijma *et al*. 2012

Themes and topics	Activity	Achievement	Implication	Reference
Theme E: Reoccupation of northern Europe after the Last Glacial Maximum (LGM)				
E.1: Post-LGM occupation flux	Synthetic study	Theoretical outline of the influence of post-LGM sea-level rise on human dispersal and socio-cultural networks	Understanding of spatial and chronological patterning of archaeological phenomena	Momber & Peeters 2017
E.2: Occupation strategies	AMS and stable isotope analysis of human remains from the southern North Sea	Insight into Postglacial hunter-gatherer diet (terrestrial and fresh water resources)	Potential for dietary studies and modelling of food economies	Van der Plicht *et al*. 2016
Theme F: Post-glacial land-use dynamics in the context of a changing landscape				
F.1: Changing landscape structure	Rotterdam-Yangtze harbour seismic mapping and coring, and palaeobotanical analysis	Insight into the effects of sea-level rise on changes in the Rhine-Meuse floodplain and estuary	Understanding of how long-term landscape change affects possibilities for human subsistence	Vos & Cohen 2015; Kubiak-Martens, Verbruggen & Kooistra 2015
F.2: Behavioural diversity among hunter-gatherers	Rotterdam-Yangtze harbour archaeological analysis	Insight into exploitation of faunal, botanical and other resources in the context of changing landscape characteristics	Understanding of how long-term landscape change affects possibilities for human behaviour	Kubiak-Martens, Verbruggen & Kooistra 2015; Niekus *et al*. 2015; Peeters *et al*. 2015; Zeiler & Brinkhuizen 2015
	Rotterdam-Yangtze harbour palaeobotanical and micromorphological analysis	Evidence for repetative firing of the marshy vegetation zone between the river dune and floodplain	Insight into deliberate influence of humans on the local environment	Kubiak-Martens, Verbruggen & Kooistra 2015
	Description and interpretative analyses of finds dating to the Middle and Late Palaeolithic, Mesolithic and Neolithic	Glimpses at various aspects of material culture and past dimensions of hunter-gatherer life	Insight into the use of raw materials and symbolism of material culture	Amkreutz, Peeters & Smit 2016; Amkreutz *et al*. 2017a, 2017b, 2018a, 2018b; Amkreutz & Spithoven in press; Niekus *et al*. 2017; Peeters & Amkreutz in press.; Niekus & Amkreutz 2018; Storm *et al*. 2014a, 2014b; Storm 2010
F.3: Maritime archaeologies of the North Sea	Rotterdam-Yangtze harbour archaeozoological analysis	Identification of full marine fish species dating to gthe Mesolithic	Insight into the exploitation of full marine resources	Zeiler & Brinkhuizen 2015
	Reporting of finds dating to the Neolithic	Identification of Middle Neolithic flint axe blades from the Brown Bank area, with an age corresponding to assumed full marine conditions	Hypothesis about offshore ritual behaviour	Peeters 2011; Van de Noort 2011
Theme G: Representation of hunter-gatherer communities and lifeways				
G.1: Spatial perspectives on North Sea palaeolandscapes	Synthetic study	Theoretical outline of the role of coasts in early hominin dispersals	Significance of submerged coastal context for the understanding of occupation patterns	Cohen *et al*. 2012
G.2: The distributional nature of early hominin communities	Synthetic study	Overview and discussion of the importance of the North Sea for the understanding of early hominin dispersals	Significance of submerged landscapes for the understanding of occupation patterns	Roebroeks 2014
	Synthetic study	Theoretical outline of the role of coasts in early hominin dispersals	Significance of submerged coastal context for the understanding of occupation patterns	Cohen *et al*. 2012
G.3: Enculturated hunter-gatherer landscapes	Synthetic study	Overview and discussion of the importance of the North Sea for the understanding of Postglacial cultural processes	Significance of submerged landscapes for the understanding of occupation patterns	Peeters & Momber 2014; Momber & Peeters 2017

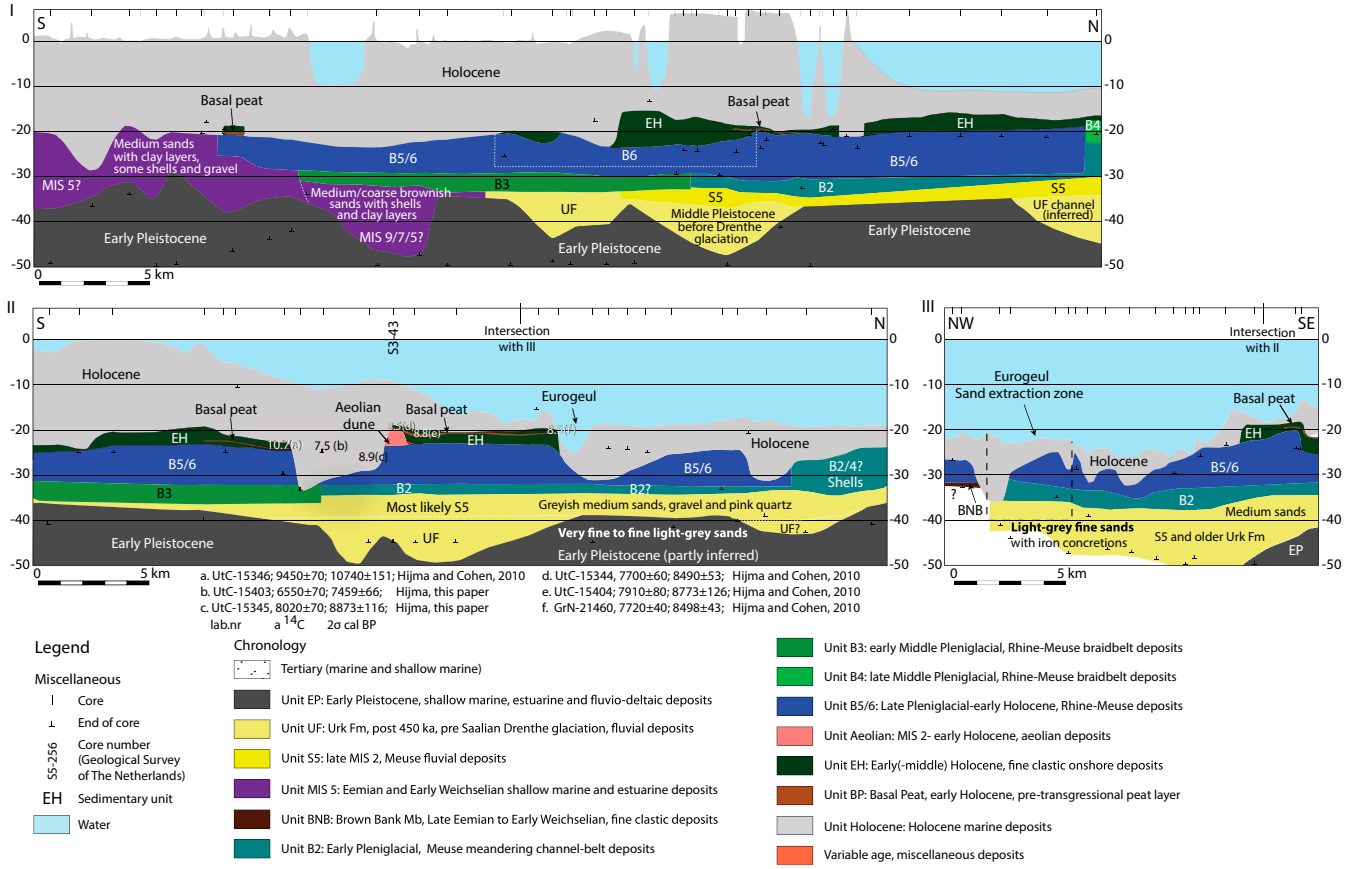

Fig 3 Geological cross-sections of the onshore and offshore areas of Rotterdam showing the stratigraphical continuity of various sedimentary units, as well as erosion, which is partly induced by modern economic activity, notably the dredging of the Eurogeul (after Hijma *et al.* 2012, Fig. 5).

BRITICE),[36] has delivered new seismic and borehole data on the Last Glacial ice-marginal landscape in that area.[37]

In order to better understand the origin and chronology of finds from the North Sea, research into the above-mentioned aspects is crucial. A good example is provided by the analysis of available geological data for the Eurogeul and Middeldiep areas,[38] which has yielded artefacts dating to the Middle Palaeolithic, a fragment of a Neanderthal skull, and countless palaeontological remains.[39] By combining bathymetry and geological data, insights were obtained on the relationship between to the seabed lithostratigraphy and the terrestrial stratigraphic record (fig. 3). This permitted researchers to identify the geological origin of the archaeological finds and to interpret them within a broader framework of landscape dynamics (fig. 4).[40]

Detailed analysis of palaeolandscape conditions, combined with insight into the timing of landscape processes, permits researchers to model changes in palaeogeography. At the Rotterdam-Yangtzehaven archaeological site it could be shown that, like areas farther inland, the location was initially situated in the Rhine-Meuse floodplain, which gradually transformed into an estuary due to an approaching coastline (fig. 5). But unlike areas inland, the site eventually became positioned seaward, off the mouth of the Rhine-Meuse estuary, leading to the truncation of the site and allowing for the preservation of the dune flank, foot, and valley floor surfaces only, not the dune tops.[41] Occupation of the river dune by Early and Middle Mesolithic hunter-gatherers continued throughout the entire process of this landscape transformation. Humans exploited the terrestrial

36 BRITICE is a GIS app which displays landforms left behind by the ice sheet that covered large parts of Britain and Ireland during the last ice age, 27,000 years ago (https://shefuni.maps.arcgis.com/apps/webappviewer/index.html?id fd78b03a74bb477c906c5d4e0ba9abaf).

37 Cotterill *et al.* 2017; Sejrup, Clark & Hjelstuen 2016; Phillips *et al.* 2018; Roberts *et al.* 2018.

38 Hijma *et al.* 2012. The Eurogeul is an artificial navigation channel which provides access to the Rotterdam harbour. The Middeldiep is an elongated depression within the zone of the Zeeland Ridges (Zeeuwse Banken) off the Zeeland coast.

39 Hublin *et al.* 2009.

40 Hijma *et al.* 2012.

41 Moree & Sier 2015; Vos & Cohen 2015.

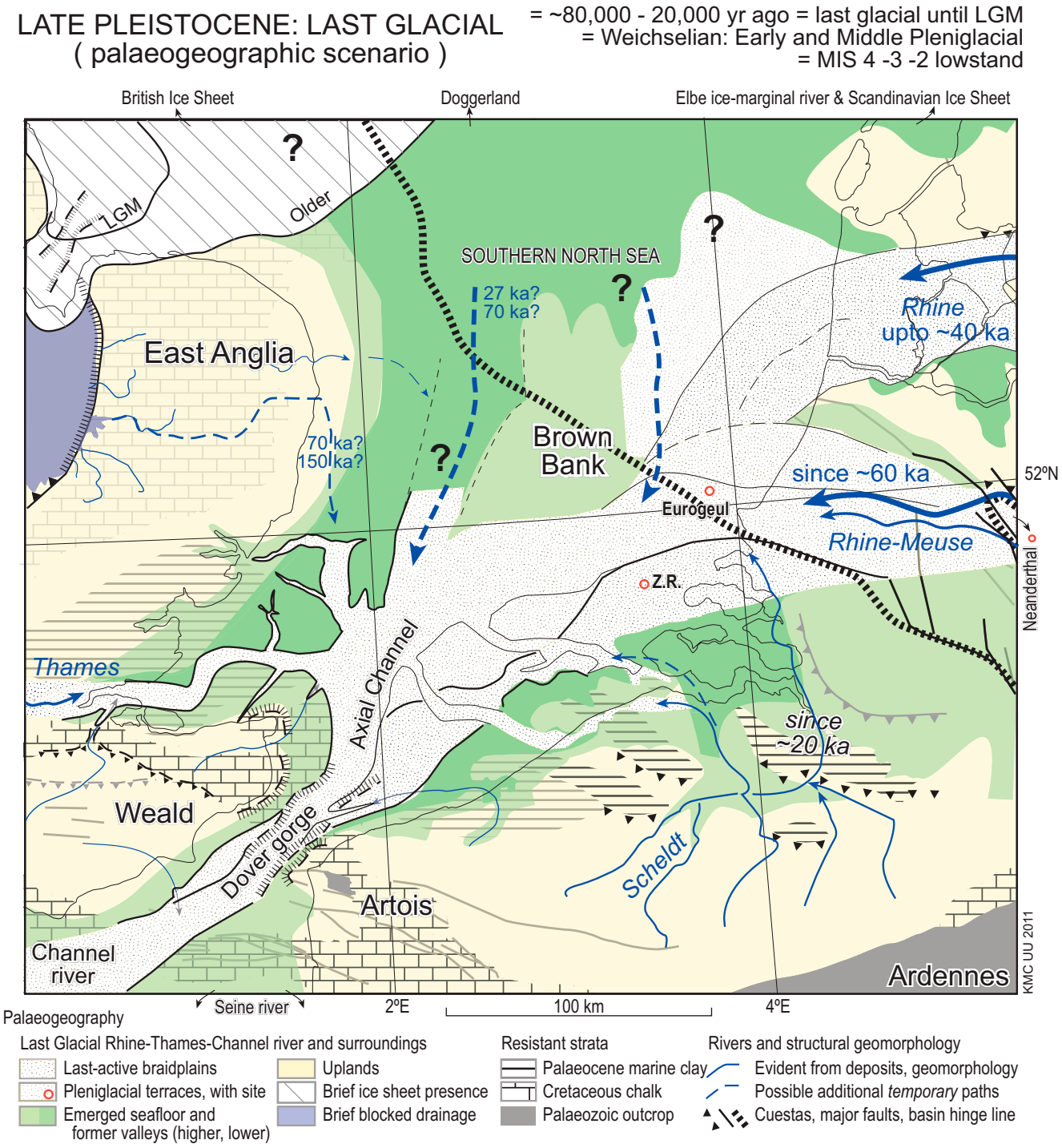

Fig 4 Reconstruction of the lowstand situation during the Weichselian Early and Middle Pleniglacial (80–20 ka ago). The map shows periglacial river valleys and possible temporary proglacial drainage systems (after Hijma *et al.* 2012, Fig. 16).

resources of the high floodplain landscape, as well as the aquatic resources (notably fish and starch-rich plants) of the freshwater wetland environments (swamp and fenland in the vicinity of rivers). The rich use of the latter is recorded within the dune toe basal peat strata, which formed in the last centuries before submergence by the rising North Sea.[42] The site, which was near the mouths of the Rhine, Meuse, and Scheldt rivers, is interpreted to have hosted a base camp that was returned to over multiple seasons and by many generations of hunter-gatherers.[43]

Whereas one might also have expected a gradual increase in the exploitation of marine resources at this site, little evidence for such an increase has been found. Clearly, multiple explanations can be proposed for the sparse evidence, ranging from sample representativeness (e.g. the remains of marine resources are simply not represented in the samples available), to taphonomic bias (e.g. the remains of the youngest – that is, near-shore – occupation phases have not survived due to erosion), to hunter-gatherer subsistence strategies (e.g. the technology of the local culture did not adapt to the exploitation of marine resources, or people made 'conservative' choices with regard to diet), to natural environmental control (e.g. sea-level rise was very rapid, estuarine river mouth habitats were shifting inland over large distance at a fast pace, and those habitats allowing for marine fishing were not close by for long). An additional possible explanation is that in the Southern Bight the shallow North Sea waters may not have become marine immediately, but were initially brackish instead.

The considerable time-depth covered by this hunter-gatherer presence on the river dune – in the context of a changing landscape and changing possibilities of access (overland and by water) – forms another intriguing aspect. At a localised scale, there is evidence for deliberate manipulation of the vegetation through burning in the marshy zone between the river dune and the floodplain, possibly to improve accessibility. This finding must also be seen as an illustration of how palaeogeographical developments and landscape processes influence the behaviour of humans and how these humans, in turn, were perfectly capable of manipulating these 'natural' conditions and set them to their needs.

Combining palaeogeographical reconstructions based on fine-grained chronological frameworks with archaeological information on human behaviour permits researchers to make connections between different scales in time and space.

The Rotterdam-Yangtzehaven site is but one of many inland dune sites in the subtly terraced floodplain preserved on the south side of the drowning Rhine-Meuse valley (low terrace levels, abandoned in Late Glacial times). On the north side of the valley, on a terrace that was more elevated above the Rhine-Meuse floodplain, inland dunes were also present. Their lower parts are preserved off Hoek van Holland and in the 'Zandmotor' sand extraction zone for beach replenishment.[44] This dune field became submerged and subsequently truncated a few centuries later than its Rotterdam-Yangtzehaven counterpart. The northerly river dunes on the higher terrace are the source area for Mesolithic finds collected on the human-made Zandmotor beaches. In the area between Hoek van Holland and Rotterdam-Yangtzehaven, where the Rhine river channel was positioned at the time of transgression, barbed points are abundant,[45] suggesting that estuarine aquatic resources were exploited in this area in Mesolithic times.[46]

With regard to sea-level oscillations in the time periods beyond the AMS calibration limit, researchers have to rely on more global reconstructions of past sea levels, which, in general, have much larger vertical uncertainties than the more regionally constructed sea-level curves. Other approaches to dating include the use of geogenetic signatures of deposits and fossil components therein and direct absolute dating by means of, for instance, OSL. However, as yet, all of these methods come with many methodological uncertainties. Research conducted in the sand extraction pits used for the Maasvlakte 2 expansion has, however, shown that useful results can be obtained from a more 'traditional' approach. Using a combination of controlled sampling of fossil marine molluscs from sand extraction pits adjacent to the Eurogeul and lithostratigraphical data from corings (carried out before the extraction and halfway the process, along the flanks of the extraction pit), lower-limit data points were obtained for sea-level positions during the Early Weichselian. Evidence for relative high stands post-dating the Last

42 Hijma & Cohen 2010; Vos *et al*. 2015; Hijma & Cohen in press.
43 Moree & Sier 2015; Peeters *et al*. 2015.
44 Hijma *et al*. 2012; Hijma & Cohen in press.
45 Verhart 1988.
46 As yet, only a few radiocarbon dates are available for the many hundreds of barbed points (Verhart 1988). These dates indicate Early to Middle Mesolithic activity. A new series of samples for AMS ^{14}C dating has, however, been sent to the radiocarbon facility at the University of Groningen.

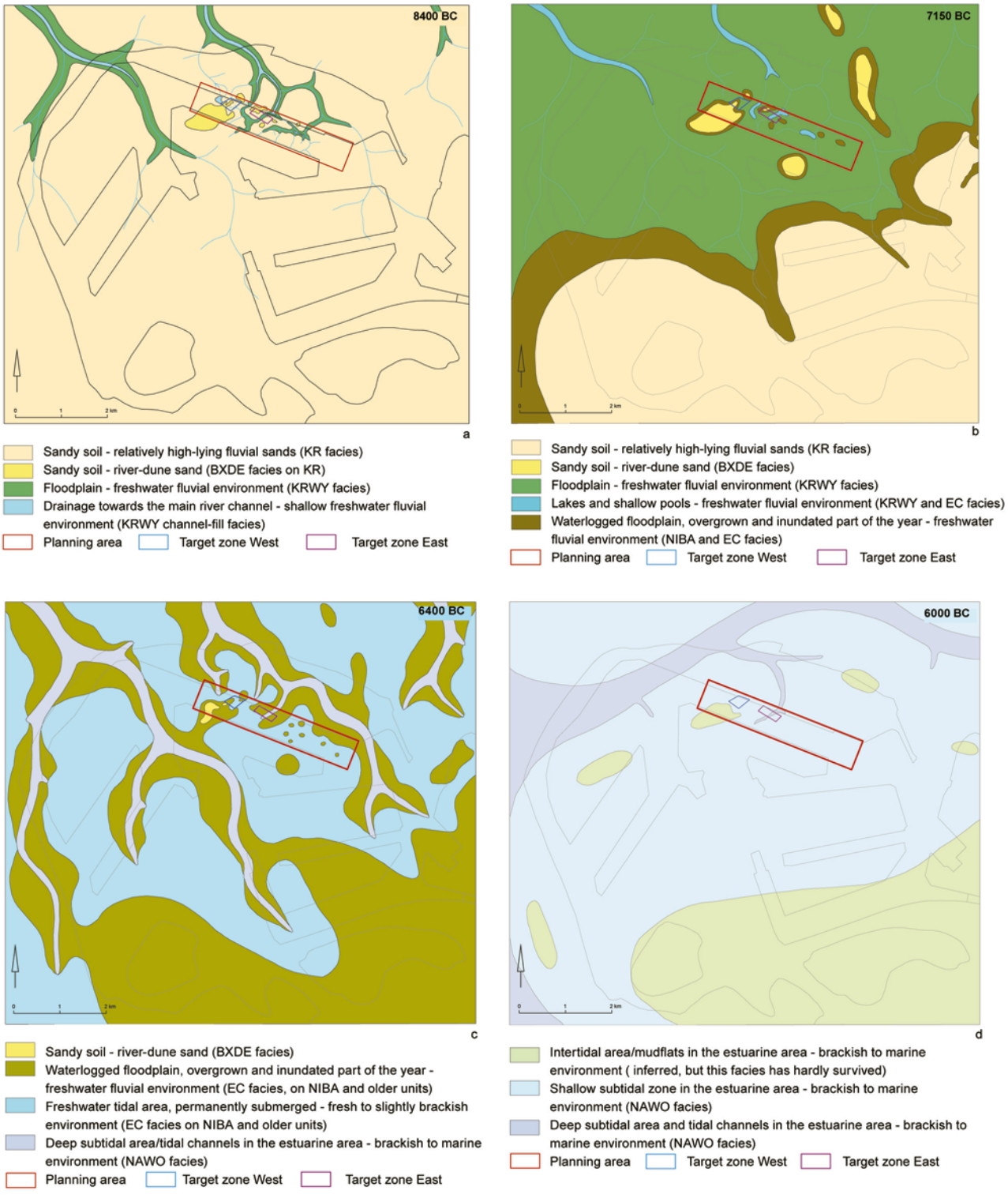

Fig 5 Time series of palaeogeographical reconstructions of the Rotterdam-Maasvlakte 2 area; Rotterdam-Yangtzehaven area is indicated by the red rectangle (after Vos & Cohen 2015, Fig. 3.19).

Interglacial (MIS 5d-a) was found at 28-32 m below mean sea level.[47]

Indications for marine conditions during the Weichselian also come from the presence of fossil bones of colder water marine mammals (beluga whale, walrus) in the assemblages trawled from the Eurogeul, the Zeeland Ridges, and the Brown Bank from various depths above -40 m and from poorly controlled contexts. These bones were encountered amidst abundant bones of steppe and tundra land animals. The remains of beluga from various find zones returned radiocarbon dates of roughly 34,600 to >47,500 BP,[48] which corresponds to the Middle Weichselian, during which sea levels are thought to have been about 40-60 m lower than today. Cases of marine mammals, such as seals and dolphins, swimming up estuaries and farther upstream are known, but in our opinion it is unlikely that beluga would have swum inland from the English Channel to reach the Eurogeul area. And the chances of finding exceptions to expected typical behaviour are clearly small in a fossil record that comprises only a few specimens of this particular species in total. The 'surprising' AMS dates on fossil beluga bones call for an evaluation of Early and Middle Weichselian high stand options,[49] radiocarbon dating uncertainty,[50] taphonomic uncertainty, and north-to-south proglacial drainage routing.[51]

3.3 Priority: the collection of good data points

The above examples demonstrate that it is possible to enhance our insight into palaeogeography and chronology within the context of development-driven projects. The collection of good data points is, of course, of paramount importance. The research conducted during the construction of Maasvlakte 2 has made a considerable contribution to archaeology, palaeontology, and palaeogeographical reconstruction and has spawned a lasting infrastructure of monitoring and registration of beach finds from artificial beaches. Underwater excavation of sites is, however, exceptional (fig. 6) because they present difficult circumstances.[52] The work in the Yangtze harbour provides an excellent example of how significant results can be obtained from such sites.

Over the past few years, offshore developments have been required to conduct research to establish the presence/absence of layers/levels or prehistoric palaeolandscape structures of potential archaeological relevance, in addition to the identification of point-located objects, such as shipwrecks (table 4). Seismic profiling is used to obtain insight into sub-bottom lithological structures. In combination with existing geological data, this seismic data is interpreted in terms of intactness of prehistoric land surfaces and presence of particular landscape features, such as river gullies and river dunes. With the exception of the AMS dating of a single peat sample from the Q10-P15 pipeline project (table 4), no further data have been collected in the context of development-driven archaeological assessments.[53] For the Kampen well site (table 4), it was concluded that 'the currently available information is insufficient to show whether the project area involves the presence of an old riverbed or sand dune, which heightens the chance of the presence of prehistoric occupation. To be able to determine this, additional drilling research would be necessary in the project area. Such an effort underwater is not in proportion to the limited size of the planned seafloor intervention.'.[54]

The character of seabed disturbance due to economic activity is variable. The extraction of sand results in large-scale and deep disturbance of continuous swaths of the seabed; the installation of windmills comes with localised, small-scale disturbances; and the routing of pipelines and cables involves linear and relatively shallow disturbances. Clearly, this situation offers variable research opportunities.[55] The approaches taken in the projects listed in table 4 are, however, similar, despite the variability in the economic developments that they were a part of. Where it comes to prehistoric archaeology and landscapes, efforts are mostly restricted to desktop studies, which combine available geological and geoarchaeological models. These models are extremely coarse-grained, but they are nonetheless being taken at face value. In addition, these models have been developed consecutively, with the aim of refining the previous iteration (see section 4.4), but neither

47 Kuitems *et al.* 2015, 370, table 3, Unit MV2-4.

48 Glimmerveen *et al.* 2004, 48.

49 If one assumes the dates to be reliable (which we do not), then it appears that for period between 30,000 and 50,000 years ago a marine high stand affected the southern part of the North Sea, which would be an exception in the global sea level record. This would have repercussions for palaeogeographic reconstructions for the offshore and onshore areas of the Netherlands, as well as models of hominin dispersal at the time of the coexistence of Neanderthals and modern humans in north-western Europe.

50 Research conducted by Busschers *et al.* (2014) has demonstrated that molluscs of confirmed Eemian and Early Weichselian age returned 'good' radiocarbon dates when they should not have, since their real age is well beyond the radiocarbon limit. These unreliable dates probably result from biochemical alteration (secondary carbonate precipitation).

51 The fossil bones could have been transported over large distances more recently than 34,000–47,500 years ago from areas to the north (e.g. as part of outwash river transport, a processes that is currently being attributed increased significance) (Hijma *et al.* 2012; Murton & Murton 2012; Cotterill *et al.* 2017; Roberts *et al.* 2018). Long-distance natural transportation will, however, show in severe alteration of the fossil bones; here, such alteration does not seem to have taken place.

52 It should be noted that underwater excavation of submerged prehistoric sites in British waters is equally rare (Bouldnor Cliff ; see Momber *et al.* 2011).

53 Van Lil & Van den Brenk 2018b.

54 Velthuis 2018, 4.

55 For a recent example of how such situations can be approached, see https://www.wessexarch.co.uk/news/secrets-doggerland.

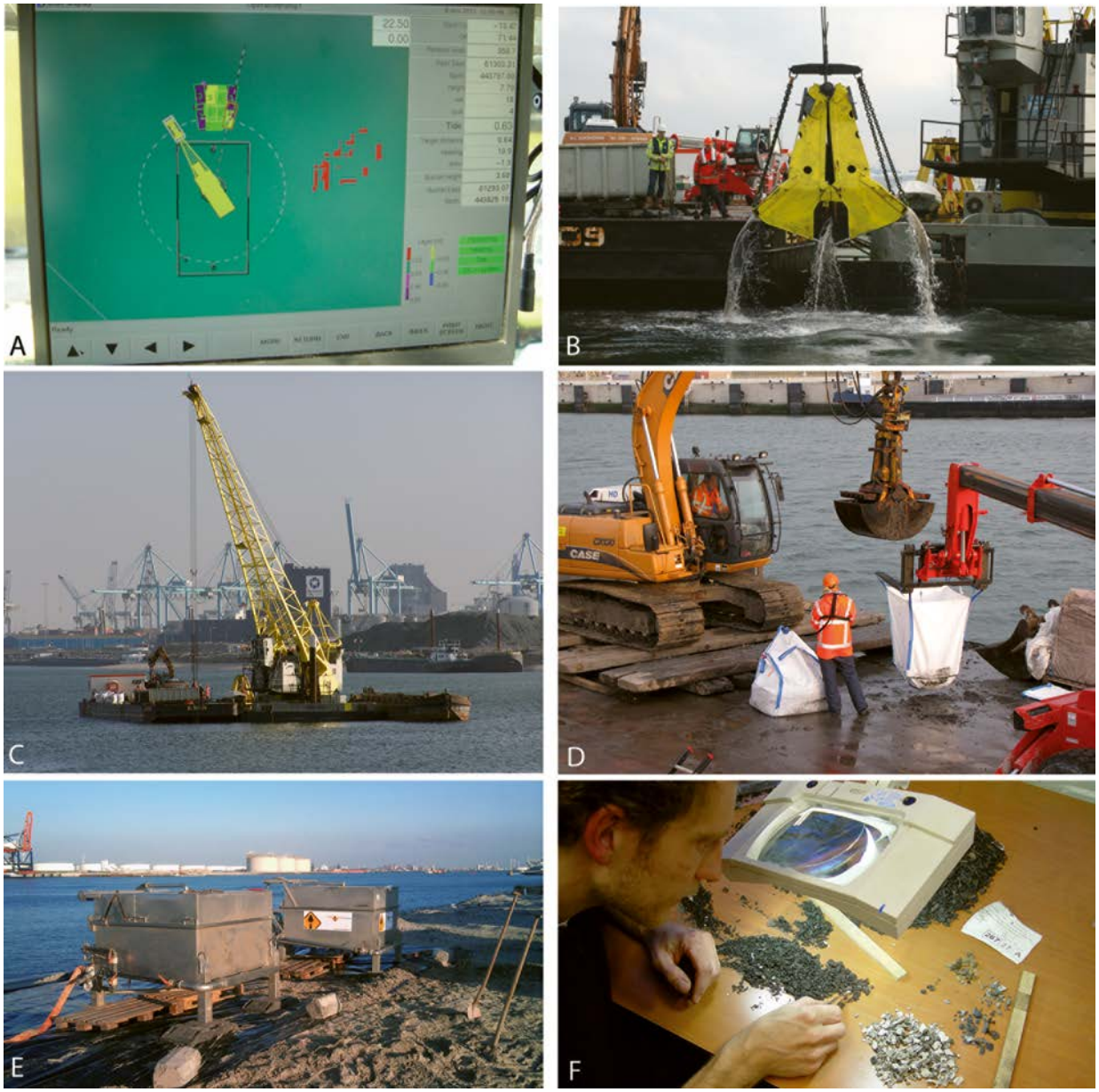

Fig 6 Underwater excavation of the Rotterdam-Yangtzehaven site. A: computer-aided control of the sample grabber, B: a grab sample being brought above water on a pontoon, C: pontoon carrying the grabbing installation, D: filling of big bags with sampled sediment, E: sieve installation designed for large samples, F: sorting of sieve sample residues (photos courtesy of D. Schiltmans, Archeologie Rotterdam [A, F], P. Vos, Deltares [B], B. Smit, RCE [C], J. van der Panne, PUMA [D], M. van den Berg, ADC [E]).

Table 4 Non-exhaustive list of offshore development projects in which archaeological assessments have been conducted. The primary research focus is without exception on the identification of isolated objects (e.g. wrecks, explosives, anchors). Seismic profiling is conducted for the purpose of palaeolandscape assessment.

Development	Research focus	Data collection	Result	Recommendation	Reference
Sand extraction L12C	lithostratigraphy; intactness prehistoric landscape surfaces	desktop study; geological data; IKAW; indicative map of archaeological potential (Vonhögen-Peeters, Van Heteren & Peeters 2016)	unknown intactness of landscape surfaces	core sampling for the purpose of palaeolandscape research	Van Lil & Van den Brenk 2017
Maasvlakte export cable routes	river dunes	seismic profiling	absent	no further action	Van Lil & Van den Brenk 2018a
Pipe lines between drilling platforms Q10-P15	intactness prehistoric landscape surfaces	seismic profiling; AMS date of basal peat	discontinuous occurrence; AMS date (GrM-14296, 7997 ± 17 BP)	no mitigating action; use information for adjustment of models	Van Lil & Van den Brenk 2018b
Neuconnect cable route	intactness prehistoric landscape surfaces	desktop study; geogenetical models; indicative map of archaeological potential (Vonhögen-Peeters, Van Heteren & Peeters 2016)	risk assessment concerning potential presence of prehistoric remains	refine geological models	Van den Brenk & Van Lil 2018
Kampen well site (block G18 Dutch continental shelf)	Pleistocene landscape structures	seismic profiling	uncertain	additional coring for confirmation not advised	Velthuis 2018
Windfarm Zone North	prehistoric landscape surfaces and structures	seismic profiling	identified zones of high potential	final construction lots avoid zones of high potential and therefore no mitigating actions needed; watching briefs during construction for potential prehistoric materials	Fugro 2017; Van Lil & Van den Brenk 2018c
Windfarm Zone West	lithostratigraphy; intactness prehistoric landscape surfaces	desktop study	written scheme of investigation	assessment following regular management procedures	https://offshorewind.rvo.nl/obstructionsw
Windfarm Zone South	lithostratigraphy; intactness prehistoric landscape surfaces; archaeological assessment	desktop study; geogenetical models; indicative map of archaeological potential (Vonhögen-Peeters, Van Heteren & Peeters 2016); core sampling	risk assessment concerning potential presence of prehistoric remains	palaeolandscape analysis	https://offshorewind.rvo.nl/obstructionszh
Windfarm Zone Borssele	assessment of archaeological potential	desktop study	risk assessment concerning the potential presence of prehistoric remains	no further action	https://offshorewind.rvo.nl/file/download/44692942
Appraisal Wells B10-04 and A15-05	intactness prehistoric landscape surfaces	desktop study; geological data; IKAW; indicative map of archaeological potential (Vonhögen-Peeters, Van Heteren & Peeters 2016)	risk assessment concerning potential presence of prehistoric remains	geophysical and geotechnical survey to test archaeological expectations (specified with regard to prehistoric landscapes)	Van Lil & Van den Brenk 2018d
Pipeline route D12B to D15A	intactness prehistoric landscape surfaces	desktop study; geological data; IKAW; indicative map of archaeological potential (Vonhögen-Peeters, Van Heteren & Peeters 2016)	risk assessment concerning potential presence of prehistoric remains	no further action due to limited depth of disturbance	Van Lil & Van den Brenk 2018e

the differences among them nor the consequences of these differences are being taken into consideration. Consequently, archaeological expectations with regard to prehistoric cultural heritage are over-simplistic and generic. Model validation has been conducted to a limited extent, notably in Rotterdam (e.g. Maasvlakte 2-Prinses Alexiahaven and Maasvlakte 2- Zwaaikom Amaliahaven).[56]

In addition, a priori statements/beliefs sometimes lead to alarming recommendations, e.g. in the context of Windfarm Zone Borssele: '(1) No early prehistoric sites have been identified within the BWFZ [meaning Windfarm Zone Borssele] itself, the nearest being 9 miles southeast of zone. (2) Where present, prehistoric remains are located at a depth of 30-40 m below sea level. This means the site has been submerged by the expanding North Sea around 7000 BCE and therefore possible settlements will most likely be older. However, population density in North-western Europe during these early stages of prehistory was very low. Therefore, the density of archaeological traces of those people is also low while the chance of any traces being well preserved is even lower. In conclusion, the chances of encountering prehistoric archaeology within the BWFZ are small (low sensitivity).'[57] This leads to the following conclusion: 'No early prehistoric sites have been identified within the BWFZ itself and the likelihood of encountering prehistoric archaeology within the zone is small. Therefore, further archaeological surveys are not recommended.'[58]

As a result of this approach, economic developments thus far have not resulted in new offshore archaeological data points. The seismic data and profiles obtained are nonetheless (potentially) important, as these can be used for the improvement of palaeogeographical reconstructions and chronology (see section 3.2), albeit that these are just starting points. To make such investigation truly useful – i.e. to ensure that the data and outcomes serve wider goals than those of underwater archaeology survey alone – it remains necessary to ground-truth (validate) inferences made from seismic readings and to obtain independent dates on samples to chronologically anchor features. As yet, good data points remain scarce.

As has been discussed in the preceding sections, the reconstruction of palaeolandscapes and the understanding of landscape processes in relation to sea-level change is of great interest to the understanding of submerged prehistoric archaeology in the southern North Sea (fig. 7). Enhancing geophysical data for the purpose of such reconstruction requires additional research to inform us about what landscapes actually looked like in broader environmental terms. Although the results of the *Doggerland Project* of the University of Birmingham are spectacular with respect to the identification of palaeolandscape structures from 3D seismic data, it is also very clear that other data are needed to permit dynamic landscape modelling.[59] The follow-up to this project, the ERC-funded *Lost Frontiers Project* of the University of Bradford, aims at precisely such enhancement, by means of targeted sampling for palaeoenvironmental research, including multi-proxy analysis of micro-fossils and DNA analysis of ancient sediments (sedaDNA).[60] Clearly, it makes no sense to randomly sample the seabed; seismic profiling is a crucial step in selecting zones of high potential for sampling, that is, to target the best spots for obtaining good data.

As mentioned earlier, sea-level reconstructions provide an important baseline for the modelling of palaeolandscape dynamics, the modelling of sea-level rise and basin subsidence rates, and the production of time series maps showing the transgression. Contrary to what might be expected in view of the long tradition of sea-level reconstruction by Dutch geologists on land and in the North Sea,[61] considerable work remains to be done.[62] The number of data points below -15 m OD, which require collecting data offshore, is particularly limited. The following statistics illustrate the differences in data density (situation 2018)[63]: from Rotterdam and surroundings, there are 83 basal peat data points, of which 46 constitute accurate sea-level indicators, covering 8300 to 3000 cal. BP (depth range: -16 to -1.5 m OD). The Maasvlakte area provides 16 such samples, of which 3 are accurate sea-level indicators, covering 9000 to 8500 cal. BP (-21.5 to -19.5 m OD). Farther offshore, for the Rhine-Meuse-Scheldt palaeovalley in the Southern Bight (including the confluence with the Thames in British-Belgian waters), 7 isolated data points

56 Schiltmans 2015; Vos *et al*. 2015; Schiltmans, Kubiak-Martens & Kooistra 2017; Schiltmans 2018.
57 Netherlands Enterprise Agency 2016, 25.
58 Netherlands Enterprise Agency 2016, 27.
59 Gaffney, Thompson & Fitch 2007; Fitch 2011; Gaffney *et al*. 2017.
60 Gaffney *et al*. 2017.
61 Jelgersma (1961) was the first to provide a relative sea-level curve for the North Sea.
62 Kiden *et al*. 2002; Sturt *et al*. 2006, 2013; Cohen *et al*. 2017; Vermeersen *et al*. 2018; Hijma & Cohen in press.
63 Sample numbers based on Hijma & Cohen (in press); age and depth ranges have been rounded.

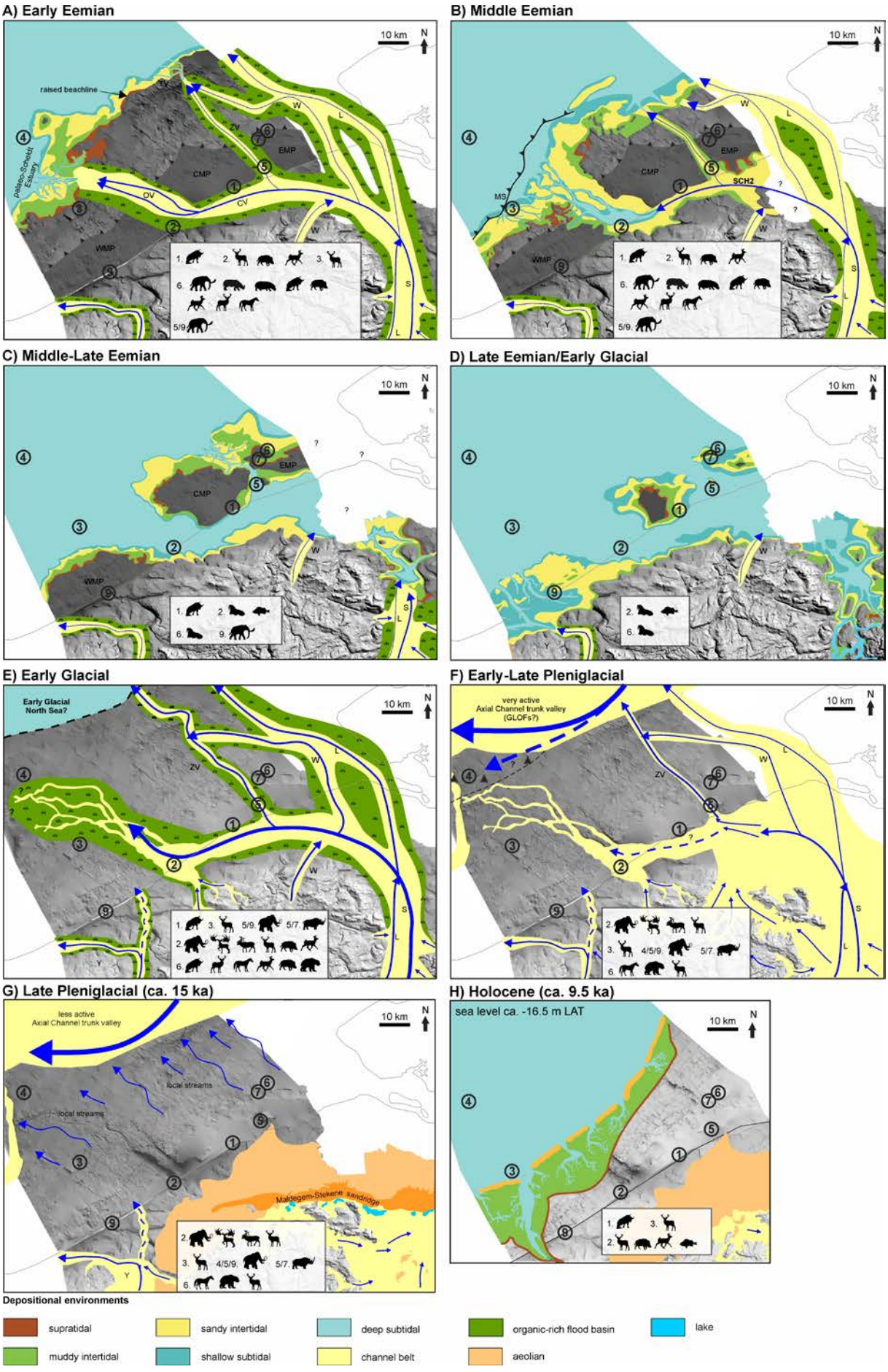

Fig 7 Time series of palaeolandscape reconstructions for the Scheldt estuary, combining information about depositional environments and fauna as known from palaeontological finds (after De Clercq 2018).

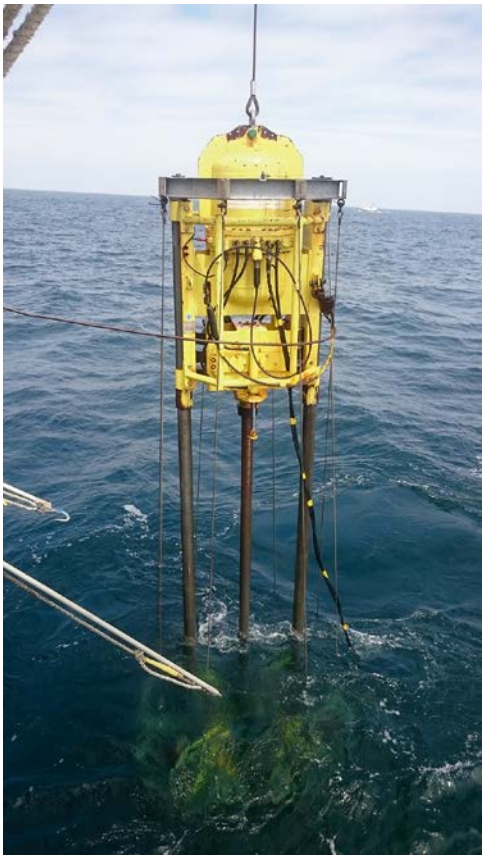

Fig 8 Vibrocore installation being sunk into the North Sea from the research vessel *Pelagia* (photo courtesy of M. Hijma, Deltares).

are known from depths between -34 and -24 m OD, the deepest of which may be sea-level indicators for the period 11,000 to 9500 cal. BP.[64] A sampling campaign by TNO-Geological Survey of the Netherlands, Deltares, and the Royal Netherlands Institute for Sea Research (known by its original, Dutch acronym, NIOZ), with participation of the University of Leeds, the Vrije Universiteit Amsterdam, and Utrecht University, is trying to fill the gap as best as possible.[65] Two expeditions (in 2017 and 2018) with the Dutch research vessel *Pelagia* were geared to the collection of basal peat samples off the Dutch coast (fig. 8).[66] In order to identify the presence and context of basal peat beds at the target depths (below MSL) and within reach of the hydraulic vibrocorer (mostly up to 4–5 m below the seabed), seismic profiles were collected and interpreted onboard. At critical locations,[67] triplets of cores were collected to provide a series of in situ basal peat samples with established palaeolandscape context, the latter being just as important for inundation modelling as for archaeology.[68] As is widely realised,[69] the sea-level rise research efforts underpin and improve the understanding of the Holocene geology and drowning history of the North Sea, and hence the archaeological understanding of how such processes may have affected people living on and near the southern North Sea coast in prehistory.

3.4 Priority: the development of prospection techniques

The work conducted at the scale of sea-floor geological mapping, palaeoenvironmental reconstruction, and sea-level research is of obvious importance, but it needs to be complemented with data commensurate with the more traditional scale of archaeological research.[70] This requires appropriate prospection techniques.

Geophysical surveying and core sampling are appropriate means through which to investigate and map geological and environmental characteristics of the substrate. However, the application of such techniques for the detection of submerged prehistoric phenomena faces many problems, as the prehistoric archaeological record is mostly characterised by diffuse – if sometimes high-density – scatters of occupation waste (often lithics) or by ephemeral manifestations of human influence on the environment (e.g. the presence of charred plant remains in deposits, or indications for disturbances in the vegetation). Anthropogenic disturbances of the subsoil, such as pit hearths and burial pits, being of restricted dimensions (up to several square meters), are difficult to detect via prospecting. Larger-scale anthropogenic disturbances of the subsoil due to digging activities, e.g. for the construction of (sunken floor) huts, are relatively rare.[71] The chances of detecting such archaeological manifestations of human presence by means of non- or minimally-invasive techniques are therefore close to zero. The discovery of knapped flint and burnt bone – as reliable archaeological indicators for human activity – in core samples largely appears to be a matter of luck,[72] be it onshore or offshore (see section 5.2 for further discussion).

64 These time/depth data are considered less accurate. The samples on which they are based were mostly collected during the pioneering stages of research, in the late 1960s to 1980s, now tens of years ago. Depth provenance measurements were less precise, while radiocarbon dates are conventional and based on bulk peat samples, which are now known to be potentially inaccurate (see e.g. Törnqvist *et al.* 1992, 1998).

65 This research is funded by the participating institutions and the Rijksdienst voor het Cultureel Erfgoed.

66 https://www.deltares.nl/en/blog/hidden-secrets-north-sea/; https://www.deltares.nl/en/blog/improving-projections-of-future-sea-level-rise/; https://www.youtube.com/watch?v=wSqfUnfKs2Q

67 Dogger Bank: -70 to -30 m; Frisian Front: -50 to -30 m; Brown Bank: -40 to -30 m; IJmuiden (near shore): -30 to -20 m OD.

68 The data will be subject to detailed analysis (lithological, sedimentological, terrestrial botanical, aquatic palynological, dating, geochemistry) in order to (1) work up the samples to new data points for the reconstruction of the Early Holocene transgressive history and (2) feed into geophysical models of regional relative sea-level rise, including the patterns of glacio-isostatic adjustment causing differential subsidence within the North Sea (e.g. Vink *et al.* 2007; Sturt *et al.* 2013; Cohen *et al.* 2014).

69 Peeters *et al.* 2009; Flemming *et al.* 2017.

70 Sturt *et al.* 2018.

71 See Peeters, Sturt & Westley (in prep.) for a broader discussion of submerged prehistoric phenomena in the North Sea and on the margins of the Atlantic Ocean.

72 Verhagen *et al.* 2013.

In the case of Rotterdam-Yangtzehaven, where a submerged site dating to the Mesolithic could be investigated at a depth of about -20m OD, a 'staged' geoarchaeological approach was taken.[73] Here, a first, desktop assessment of the available geological data (regional-scale reconstruction of palaeolandscape based on seismic data and archived core materials) was undertaken, followed by validation of the seismic data by means of cone penetration probing (depth of encounter, preservation of palaeosurfaces). In a next step, further seismic investigations were used to refine the spatial model (i.e. local landscape reconstruction) of the submerged and sediment-buried palaeosurface in the Late-Glacial landscape. In this phase of detailing, inland dune features were identified, which are known to have a high potential for the presence of archaeological remains (as is evident from virtually all such sites investigated onshore) (fig. 9). This new model formed the basis for the selection of some smaller target areas (and for refraining from further survey in the remainder of the harbour basin). These target areas were then subjected to a geoarchaeological assessment by means of a fairly dense network of high-quality cores. Some cores yielded samples containing knapped flint and burnt bone, providing evidence for an archaeological site. Although the top of the river dune complex had eroded, it was decided to excavate several 'windows' on the dune slopes by means of a grab-sampler, modified for this particular purpose to allow for control over sample position and depth.

Obviously, the success of detecting a prehistoric site in this particular project depended on the input of expert knowledge. Is it appropriate in this case to also attribute the success to luck? Perhaps not, since river dune slopes generally bear considerable quantities of occupation waste.[74] Given the experience at the Yangtze harbour, a similar approach to the prospection of submerged river dunes farther

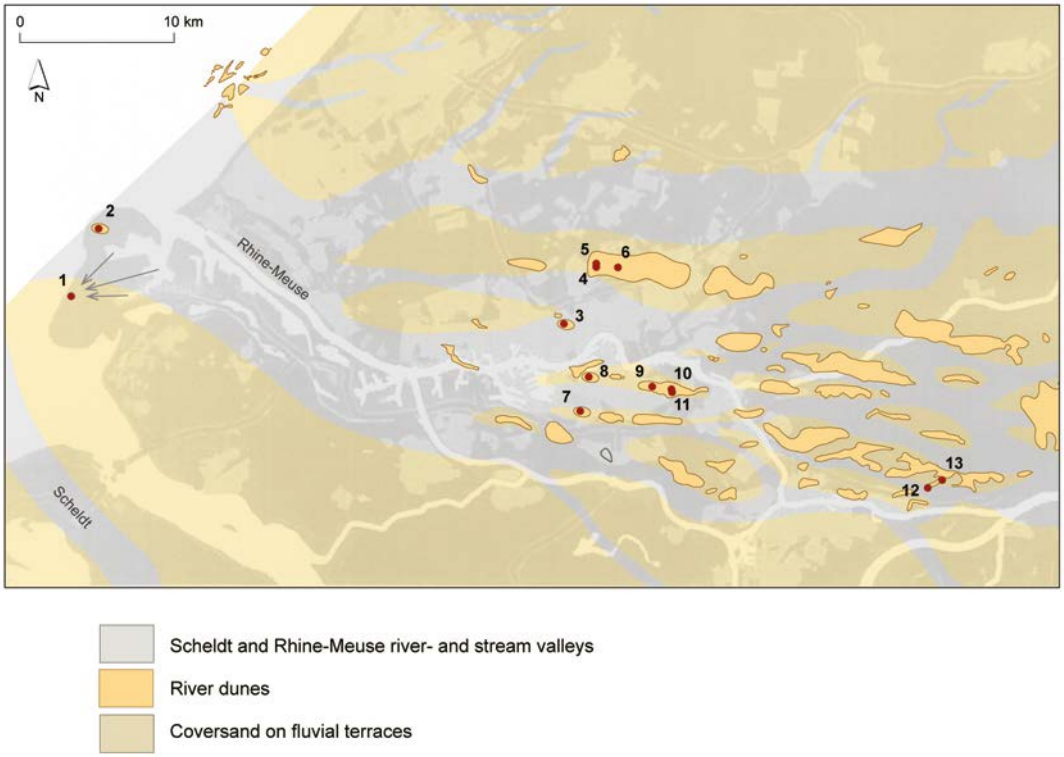

Fig 9 Location of Mesolithic sites in and around Rotterdam in relation to the river dune complexes identified by detailed mapping programmes (compiled by Archeologie Rotterdam). 1. Rotterdam-Maasvlakte 1; 2. Rotterdam-Yangtzehaven; 3. Rotterdam-Emplacement Centraal Station; 4. Rotterdam-Hillegersberg; 5. Rotterdam-Grindweg/Argonautenweg; 6. Rotterdam-Bergse Bos; 7. Rotterdam-De Velden; 8. Rotterdam-Blankenburgstraat/Hoogvlietstraat; 9. Rotterdam-'t Hart; 10. Rotterdam- IJsselmonde; 11. Rotterdam-Beverwaard Tramremise; 12. Hardinxveld-De Bruin; 13. Hardinxveld-Polderweg (after Peeters *et al.* 2015, Fig. 7.4).

[73] Vos, De Kleine & Rutten 2012; Vos & Cohen 2014–2015; Vos *et al.* 2015.

[74] See Amkreutz (2013) for an overview. This is not to say that the chances of finding such materials in small core samples are statistically high.

offshore in the North Sea may be fruitful. However, one must bear in mind that hunter-gatherer dwelling was not restricted to river dunes or to other elevated elements of the landscape in the floodplain. Localised, 'thin' clusters of remains can be present in clayey flats in the floodplain,[75] but the statistical chance of them being detected by means of coring is close to zero.

In reference to Rotterdam-Yangtzehaven, it is also worthwhile to pay attention to the inclusion of charred plant remains – fragments of stems and leaves of reeds in particular – in clastic sediments. At Rotterdam-Yangtzehaven, in situ and horizontally embedded reed remains are thought to be the result of deliberate and repeated clearing of vegetation adjacent to the dwelling site. Comparable observations have been made for other sites in the Netherlands (e.g. near Almere)[76] and the United Kingdom (e.g. at Star Carr).[77] Charred plant remains in clastic sediments elsewhere could indicate the presence of dwelling sites nearby.

The many stray finds from fishing nets and infrastructural projects indicate that certain areas have a high potential for Palaeolithic (Pleistocene) and Mesolithic to Neolithic (Early and Middle Holocene) faunal remains, lithics, and organic artefacts, as well as human remains. The majority of these finds are more voluminous than the Mesolithic remains encountered in the Yangtze harbour, and would generally not even fit auger diameters. Of course, the size distribution relates to discovery context. For instance, finds from fishing nets will always be bigger than the mesh size of the nets, whereas finds from beaches and reject piles will be smaller than the mesh of the dredging screens and will have a minimum size strongly related to the observational capacities and focus of the collector. Leaving aside such biasing factors, the question is how such Pleistocene to Middle Holocene remains are spatially distributed on/in the seabed. For this we have to rely on observations onshore. This record demonstrates a range of distribution patterns (from extended, diffuse scatters to high-density accumulations) that can best be approached from an 'off-site' perspective.[78]

The discovery in 2007 of more than 80 artefacts, mostly hand-axes, originating from one specific gravel-extraction pit (Area 240) off Great Yarmouth, on the British coast, provides an example of an approach that appears to be effective for the detection/exploration of find contexts characterised by extended, diffuse scatters of artefacts.[79] In collaboration with industry, research consisted of a geoarchaeological assessment to determine the original sedimentary context of these artefacts, by means of a geological study and grab sampling aimed at collecting further artefacts in order to corroborate the origin of the initial finds (fig. 10).[80] This approach proved successful, and it is without doubt a way forward to increase the chances of locating in situ occurrences of prehistoric remains in general. Admittedly, grab-sampling approaches are highly intrusive and

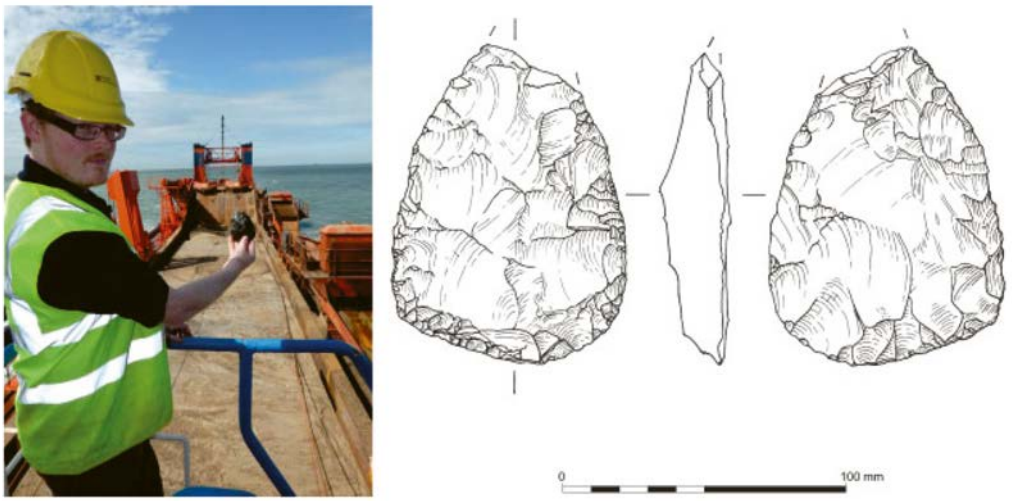

Fig 10 Middle Palaeolithic hand-axe uncovered during the geoarchaeological survey of licence Area 240 (after Tizzard *et al.* 2014, Fig. 8).

75 E.g. Mesolithic sites in the Meuse floodplain near Well and Aijen, in the province of Limburg (Müller, Tebbens & Flamman 2018).

76 Woltinge 2009.

77 Dark 1998; Milner, Conneller & Taylor 2018a, 2018b.

78 Cf. Foley 1981. The off-site concept as proposed by Foley (1981) takes an explicit taphonomic perspective on the diachronic emergence of distribution patterns at a landscape scale and moves away from the narrow definition of 'site' as a restricted zone arbitrarily delimited on the basis of find density that is subsequently considered to represent a functionally labelled type of location. The latter approach prevails in archaeological landscape studies (not only in the Netherlands), but comes with many conceptual/methodological problems (cf. Peeters 2007).

79 Middle Palaeolithic 'sites' often consist of a 'veil of stones' (Roebroeks *et al.* 1992) – a continuous distribution with lower and higher densities of artefacts, resulting from a complex taphonomic history (cf. Foley 1981).

80 Bicket *et al.* 2014; Tizzard *et al.* 2011, 2014, 2015.

destructive, but, as underlined in the NSPRMF 2009, in order to obtain new good data points, we must accept some degree of disturbance. However, such coarse-grained data should be complemented by high-resolution stratigraphic and palaeoenvironmental research in order to provide context and to enable the development of more detailed archaeological investigation.

3.5 Conclusions

Over the past 10 years, a lot of research has been conducted, in various forms, that is of relevance to the research priorities of the NSPRMF 2009. The extent to which these priorities are met is variable.

Efforts have been geared towards gaining a better understanding of geological factors affecting the taphonomic histories of submerged prehistoric landscapes, as well as those of archaeological and palaeontological finds. Various studies have provided insight into sea-level fluctuation and changing palaeogeography, factors that are of direct archaeological relevance for our understanding of prehistoric human–environment interrelationships and socio-cultural processes.

As yet, the collection of good data points appears to lag behind. Significant results have been obtained with respect to underwater investigation of sites (Rotterdam-Yangtzehaven), the geological contextualisation of finds with limited context information (Middeldiep, Rotterdam-Maasvlakte 2), as well as systematic inventorying and scientific analysis (AMS ^{14}C dating, stable isotope analysis) of stray finds. The number of new good data points collected over the past decade is, however, limited.

To increase the number of good observations (data points), prospection techniques need to be further developed. The staged approach (geoarchaeological assessment, archaeological sampling, excavation) implemented at Rotterdam-Yangtzehaven was successful, and showed what can be achieved under particular circumstances and within a particular project context. However, in view of the variability in archaeological manifestations of prehistoric behaviour known from the North Sea, as well as the variable character and impacts of economic developments on the seabed, other prospection techniques (including destructive ones) need to be considered and developed.[81]

In view of these results, it is safe to conclude that the themes and topics of the NSPRMF 2009 research agenda remain topical and relevant with respect to international programmes. Opportunities to collect new data to increase scientific insights into these themes and topics continue to exist. Hence, there seems to be no reason to consider changes at this point.

[81] In 2018, experiments were conducted to sample the top of the (peat-covered) Pleistocene surface in a development area in the Markermeer by means of a GPS-controlled suction sampler (called the Marine Prehistory Sampler; see e.g. https://www.youtube.com/watch?v=oQdxdWTAbpI). The approach targets the collection of voluminous samples (2 m^3) in order to increase the chance of detecting archaeological material.

4 The development of management tools

4.1 Introduction

The NSPRMF 2009 management agenda lists a restricted number of themes and topics that connect to the necessity to bring together economic stakeholders, heritage professionals, and scientists. Although not adopted as a priority, an important aspect of the management agenda concerns informing a wider audience.

The merits of the NSPRMF 2009 concerning the management agenda can be traced in an array of publications, reports, and documents, as well as in management actions. Table 5 provides a summary of activities, achievements, and implications with respect to the themes and topics listed in table 2.[82] The following sections discuss these in the context of the NSPRMF management priorities.

4.2 Priority: collaboration with industry and private collectors

Industry and private collectors represent two major, related sources through which information about prehistoric landscapes and archaeology in the southern North Sea is, or can be, delivered, as is expressed in several publications. Collaboration is perceived as a prerequisite to increase our knowledge and to firmly embed archaeological objectives into a range of procedures that often are connected with (inter)national legislation and regulations.[83]

An important step in the collaboration with industry was taken with the development of a research framework in the context of the Rotterdam harbour extension Maasvlakte 2.[84] It was the outcome of a long trajectory of dialogue between the harbour authorities, the archaeological service of the municipality of Rotterdam (Bureau Oudheidkundig Onderzoek Rotterdam, now Archeologie Rotterdam), and the Dutch state service for archaeological investigations (Rijksdienst voor het Oudheidkundig Bodemonderzoek, now the Rijksdienst voor het Cultureel Erfgoed).[85] The framework served as a guide for the development of an approach to obtain archaeologically significant information within the context of a highly complex project, which of course came with many restrictions in terms of time, money, engineering, logistics, and safety. Mutual trust that all parties involved were reliable, and the recognition that choices had to be made, led to an unmatched project, in which not just responsibilities but also opportunities were taken.

The organisation responsible for the actual harbour construction works[86] assumed an important role in the technical realisation of the research. This made it possible to investigate archaeological find layers at a depth of -20m OD.[87] The plan was to dredge sand from pits off the coast and adjacent to the Eurogeul – already known as an important palaeontological find zone – and to use this sand for the construction of Maasvlakte 2. It was understood that this sand would, without doubt, yield quantities of palaeontological and, possibly, archaeological remains. Hence, procedures were conceived to collect information about the stratigraphic origin of any such materials that were expected to surface on the new Maasvlakte 2 beach during and after construction.[88] The beach itself was surveyed through field walking and through systematic collection of materials by means of a beach cleaner.

The decisions taken during the entire construction process resulted in many important new scientific insights, notwithstanding the loss of detail that had to be accepted.[89] But just as important are the efforts taken to inform and involve the public. For this purpose, an information centre (Futureland) was built on the Maasvlakte itself to receive groups of pupils and individuals, initially to inform them about the Rotterdam harbour construction, and later to also inform them about the archaeological and palaeontological research that was being conducted. Experts in archaeology and palaeontology were present during organised open days to tell collectors about what they had found, and how such finds help scientists to reconstruct prehistoric landscapes and human life in the past. Assisted by experts, visitors could go out to try their luck on the beach. In addition, in collaboration with Archeologie Rotterdam and the Natural History Museum, the Port of Rotterdam designed a portal (Oervondstchecker) (fig. 11) where collectors can report their finds[90] and receive replies from experts with regard to their nature and significance.

82 Note that table 5 contains references which are not necessarily repeated in the text.
83 Flemming 2004; Flatman & Evans 2014; Flemming *et al.* 2014; Salter, Murphy & Peeters 2014.
84 Manders *et al.* 2008.
85 Maarleveld & Peeters 2004.
86 Projectorganisatie Uitbreiding Maasvlakte (project organisation expansion Maasvlakte, known as PUMA).
87 Schiltmans & Vos 2015.
88 Kuitems *et al.* 2015.
89 Moree & Sier 2015. The extensive report on the investigations in the Rotterdam-Yangtzehaven basin and sand wells, and on materials collected on the beach, received excellent reviews (Innes 2015; Firth 2016), which applauded the approach as providing an outstanding example of how to deal with such complicated underwater research settings.
90 https://oervondstchecker.nl. The Dutch word oervondst roughly translates as primeval find.

Table 5 Summary of merits of the NSPRMF 2009 concerning the management agenda.

Themes and topics	Activity/Context	Achievement	Implication	Reference
Theme H: Legislation and preservation				
H.1: Defining prehistoric cultural heritage	European Marine Board – SUBLAND	European Marine Board Position Paper 21	Joint geoscience-humanities strategy for European Continental Shelf Prehistoric Research	Flemming *et al*. 2014
	COST-Action TD0902 SPLASHCOS	Scientific publications; EMB-supported workgroup SUBLAND;	EU-wide network of researchers and heritage professionals	Bailey *et al*. 2012
H.2: Common ground for the protection of the historic and natural environment	European Marine Board – SUBLAND	European Marine Board Position Paper 21	Joint geoscience-humanities strategy for European Continental Shelf Prehistoric Research	Flemming *et al*. 2014
H.3: Conservation of submerged prehistoric landscapes in a dynamic environment	Exploration of predictive modelling	Joint efforts by governmental bodies	Shared sense of responsibility	–
Theme I: Assessment and data sharing				
I.1: Research potential and threat mapping	Rotterdam-Maasvlakte 2	Research framework	Defined research potential and scope for the Maasvlakte 2 development	Manders *et al*. 2008
	Increasing offshore economic activity	Assessment of the possibility to develop an indicative map of archaeological values affected by high degree of variability in data resolution	Development of an indicative map of archaeological values can only be done in phases	Erkens *et al*. 2014
	Increasing offshore economic activity	Geoarchaeological map of potential preservation of prehistoric landscape remains	Indicative map of preservation potential of prehistoric remains in the Dutch sector of the North Sea for management decision-making	Vonhögen-Peeters, Van Heteren & Peeters 2016
	12 mile zone sand extraction	Assessment of preservation potential within the 12 mile zone based on modelled preservation of basal peat	Indicative map of preservation potential of prehistoric remains in the 12 mile for decision-making in respect to sand dredging	Vonhögen-Peeters, Maljers-Oosterwijk & Peeters in prep.
I.2: Surveying	Impact assessments of offshore developments	Geophysiscal mapping of potentially important zones for prehistoric archaeology	Integration of submerged prehistoric archaeology in impact assessments	Van den Brenk & Van Lil 2018; Van Lil & Van den Brenk 2018a, 2018b, 2018c, 2018d, 2018e; Velthuis 2018
I.3: Data sharing and find reporting	COST-Action TD0902 SPLASHCOS	SPLASHCOS-viewer (web portal to submerged sites on the European continental shelf)	Availability of information about submerged prehistory	http://splashcos.maris2.nl/
	EC DG MARE initiative Marine Knowledge 2020	EMODnet data portal	Integration of submerged landscape data and data on human activity	http://www.emodnet.eu/; http://www.emodnet.eu/human-activities
	Rotterdam-Maasvlakte 2	Portal for find reporting	Fosters data collection based on finds reported by private collectors	https://oervondstchecker.nl
I.4: Co-operation	COST-Action TD0902 SPLASHCOS	EU-wide network of researchers and heritage professionals	Fosters cross-national projects	Bailey *et al*. 2012
	Rotterdam-Maasvlakte 2	Solutions to the integration of prehistoric archaeology in complex offshore developments	Co-operation between industry, scientists and heritage professionals	Symposium 20 Meters Deep!; Weerts *et al*. 2012; Moree & Sier 2015
Theme J: Public outreach				
J.1: Changing worlds	Rotterdam-Maasvlakte 2 harbour extension	Visitor centre 'Futureland'; 'meet the experts' open days; accompanied fossil collecting on the Maasvlakte 2 beach	Fosters enthousiasm among economic stakeholders, public and heritage professionals/ scientists	www.futureland.nl

Themes and topics	Activity/Context	Achievement	Implication	Reference
	Book on world history of the Netherlands: 'Wereldgeschiedenis van Nederland'	Opening chapter in nationally very succesful book on Dutch history	Provides a very wide audience with a glimpse of the potential of North Sea prehistoric archaeology	Amkreutz & Dusseldorp 2018
	Expert 'open days' specifically on prehistoric finds and fossils from the North sea in the National Museum of Antiquities	Documenting finds; creating a network of knowledgeable enthusiasts	Creates increased public awareness and a network of information	RMO
	The long draw of creativity: ochre and engraved lines	Public oriented publication oldest art	Creates public awareness	Pitts 2018
	Steinaxt aus Doggerland	Public oriented publication core axe	Creates public awareness	Angelicka Franz 2013: http://www.spiegel.de/wissenschaft/mensch/doggerland-artefakte-finden-sich-in-der-nordsee-a-905737.html; appeared earlier in British Archaeology
	Various smaller exhibitions on North Sea prehistoric archaeology (Krijn; handaxes Area 240; Archeologie van Nederland) and important position in permanent exhibition	Exhibitions in national Museum of Antiquities/RMO	Creates public awareness	RMO
	Book Schatten van het Mammoetstrand	Drawing the attention of media and public	Increased activity of private collectors	Van Ginkel, Reumer & Van der Valk 2014
	Press releases concerning finds and research	Drawing the attention of media and public	Increased activity of private collectors and informing the public about human-environment interrelationships	See table 6
J.2: 'Them' and 'Us' | 'Nature' and 'Culture'	Press releases concerning finds and research	Drawing the attention of media and public	Increased activity of private collectors and informing the public about human-environment interrelationships	See table 6

Since its launch in 2014, more than 11,000 finds have been reported via the Oervondstchecker portal,[91] of which about 240 were determined to be archaeological in nature. Finds are also being reported to e.g. the national museum of antiquities (Rijksmuseum van Oudheden), Archeologie Rotterdam, the Rijksdienst voor het Cultureel Erfgoed, and universities. Apart from the Oervondstchecker portal, the informal Doggerland Research Group (Werkgroep Steentijd Noordzee) has established a database of the active community of amateur archaeologists and palaeontologists and their collections. Extra expertise days with a specific archaeological focus are organised on a regular basis to serve as a means of documenting most discoveries. The gain is that potentially significant finds become known to the research community and that contacts with collectors guarantee further reporting of new finds. And indeed, many exciting finds have come to the attention of the scientific community (fig. 12) – notably human remains, Pleistocene hyena coproliths, a range of Palaeolithic artefacts (including a hand-axe made out of Wommersom quartzite), bone points, a projectile point embedded in a red deer mandibula, Mesolithic stone tools, and a wealth of fossil bones. These efforts have boosted the attention of the media for the topic of submerged archaeology and landscapes (see section 4.6).

These initiatives have also created a good basis for the reporting of finds by individual amateur collectors. There are also (semi-) professional collectors who have been very active when the (beam-trawling) fishing and aggregates industries were still bringing quantities of palaeontological and, to a lesser extent, archaeological materials ashore, but these collectors have been in close contact with museums for a while now, notably the natural history museum in Rotterdam (Natuurhistorisch

[91] This number includes objects that were erroneously believed to be fossils or artefacts when reported.

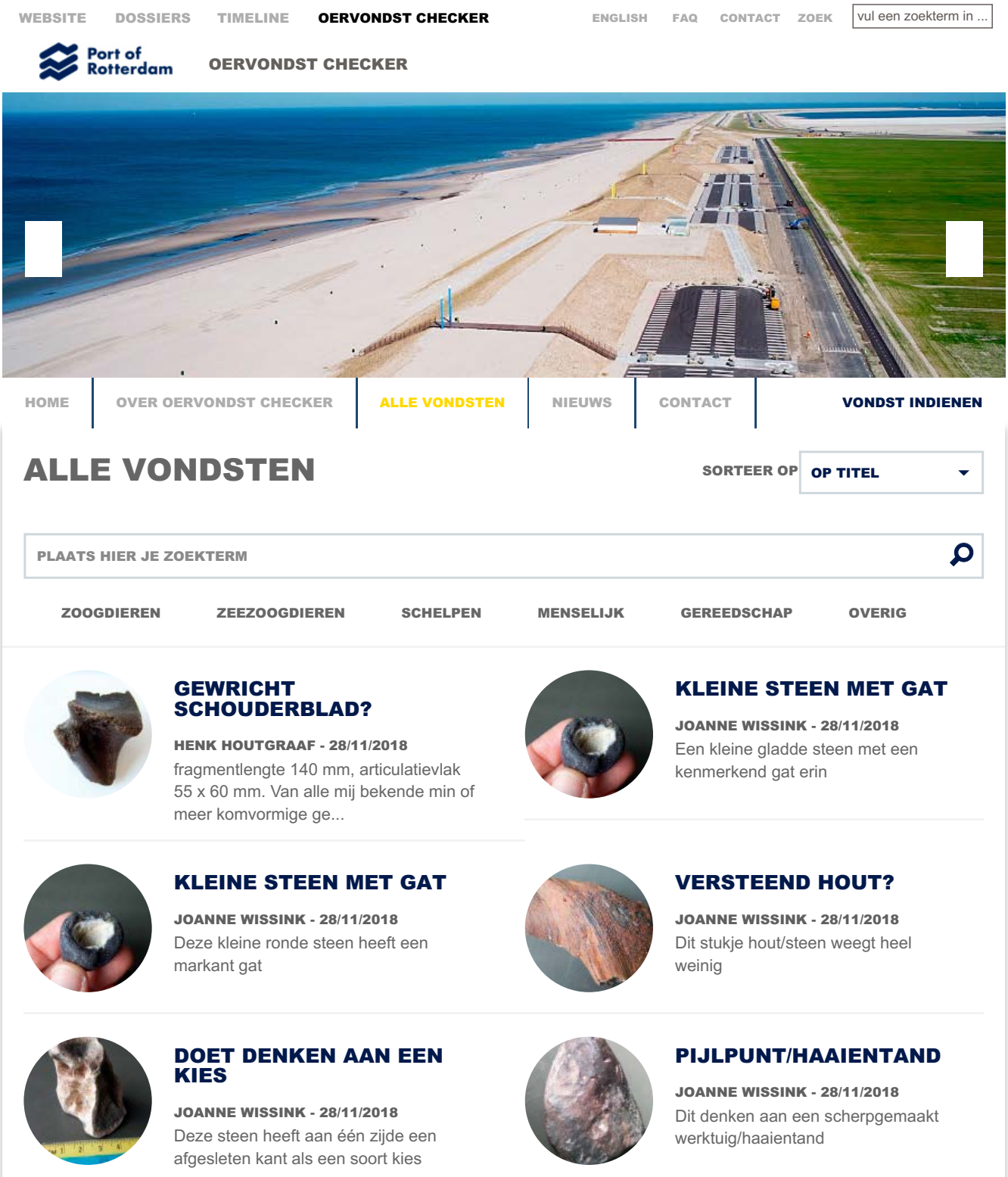

Fig 11 Home page of the online 'oervondstchecker'.

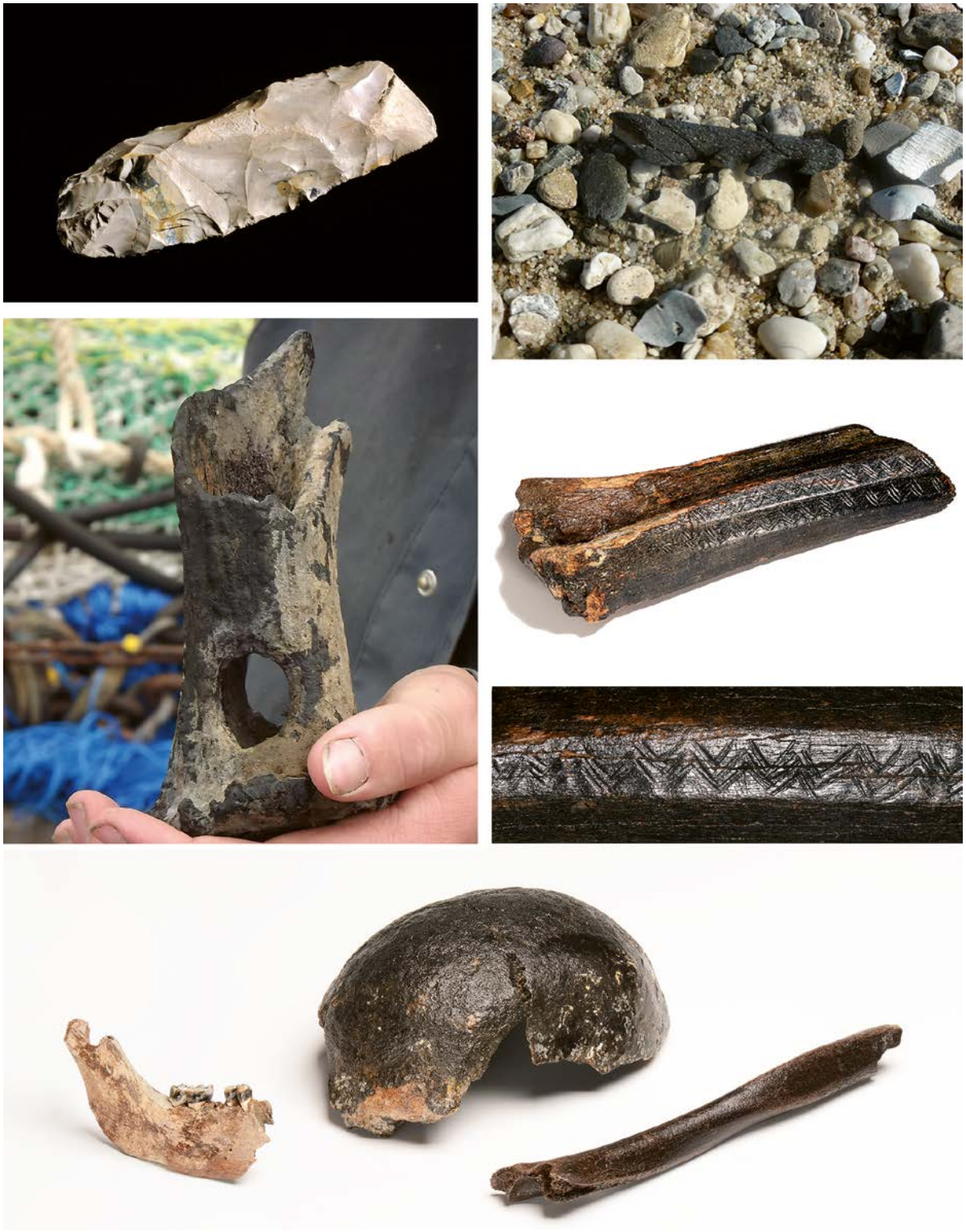

Fig 12 A small selection of finds from the southern North Sea (photos courtesy of RMO unless stated otherwise). Top left: Mesolithic core axe fished up in the Brown Bank area; top right: fragment of a barbed point on the artificial beach of Rotterdam-Maasvlakte 2 (photo courtesy of M. Spithoven); middle left: Mesolithic perforated red deer antler from Rotterdam-Maasvlakte 2 (photo courtesy of D. Mol); middle right: Late Palaeolithic decorated bone fished up southwest of the Brown Bank; bottom: Mesolithic human remains from the North Sea and beach.

Museum Rotterdam), the Naturalis museum and the national museum of antiquities (Rijksmuseum van Oudheden), both in Leiden. Because beam trawling is no longer practiced, the number of finds is rapidly decreasing; it is estimated that there has been 95% reduction in the number fossils being brought ashore,[92] and the number is predicted to decrease further in the years to come.

The aggregates industry, however, remains a factor of importance and concern, and here problems emerge with respect to the accessibility of wharves. Authorisation to access wharves to look for palaeontological and archaeological materials on reject piles is difficult to obtain due to the perception on the part of companies that they risk intervention by legal authorities in the case of important finds. For example, the discovery of a collection of Middle Palaeolithic artefacts on a Dutch wharf in Flushing, but originating from license Area 240 in British waters, led to an intervention by English Heritage, which was readily accepted by the British dredging company. The collaboration between the dredging company, English Heritage, the state service for archaeological investigations in the Netherlands, and the finder of the artefacts was exemplary – indeed, it received the British Archaeological Award for Archaeological Discovery of the Year in 2008 (fig. 13). However, the wharf in Flushing prohibited any further collecting of materials on its premises, citing economic damage due to a lesser quality of gravel, which subsequently had to be delivered from different pits.[93] Similarly, after the widespread attention for the discovery of a Neanderthal skull fragment at another wharf, amateur palaeontologists were banned from that wharf. 'Reasons of security' were mentioned, whereas security was never said to be problematic before (there were contracts in order to prevent liability). Efforts by the Rijksmuseum van Oudheden and the Rijksdienst voor het Cultureel Erfgoed to solve this problem remained unsuccessful; there appear to be no legal means at the moment to change the attitude of wharf owners towards collectors. The outcome may very well be that the information flow from active amateurs to the scientific world will dwindle because the attention garnered by their finds may ultimately result in them having to give up their hobby.

Fig 13 The winning team of the British Archaeology Award 2008 for the archaeological discovery of the year, with representatives of Hanson Aggregates Marine, and Mr. Jan Meulmeester (second from right), who discovered tens of hand-axes on a wharf in Flushing.

92 Personal communication Mr. K. Post (November 2018).

93 The upcoming exit of Great Britain from the European Union might complicate matters even further.

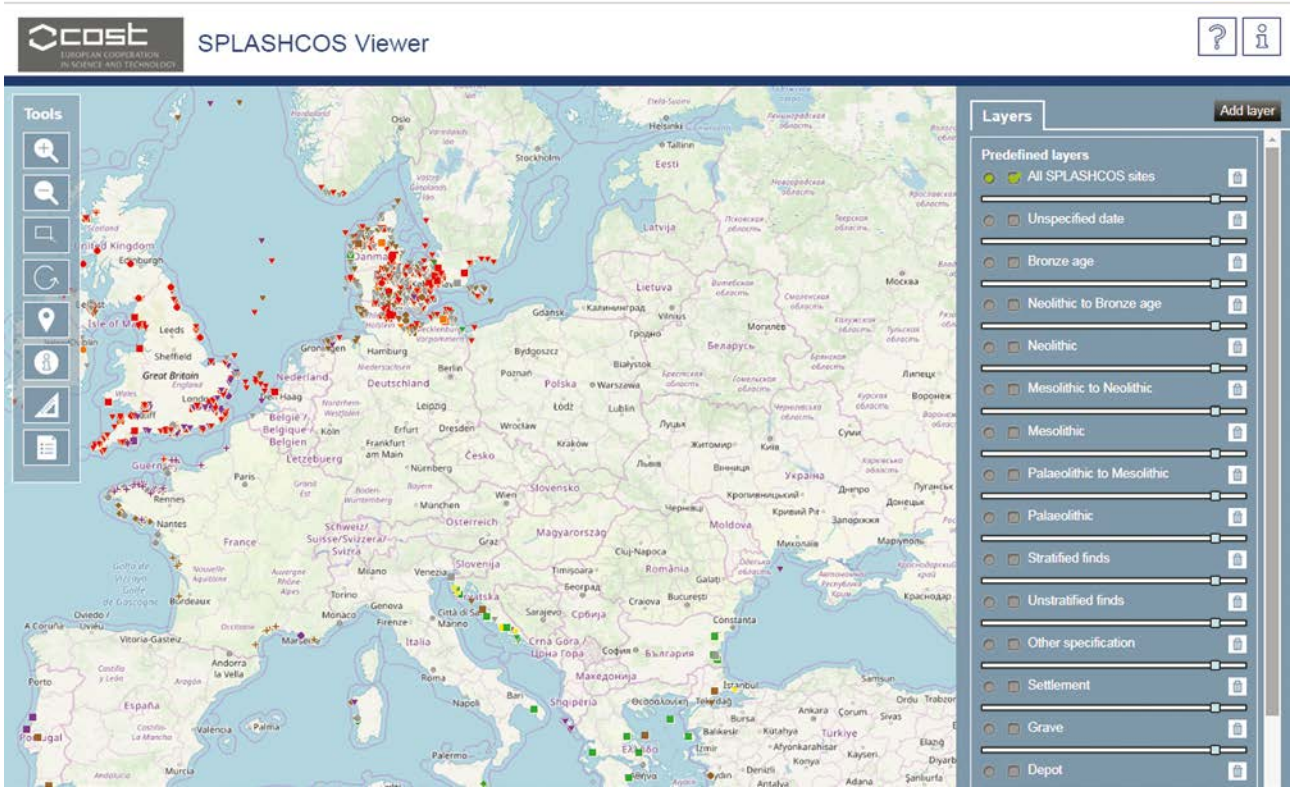

Fig 14 Home page of the SPLASHCOS-viewer.

4.3 Priority: data sharing

Important steps have been taken with respect to data sharing. The EU-COST project SLASHCOS has triggered several initiatives. The first is the so-called SPLASHCOS-viewer,[94] which intends to provide basic information about the age of submerged sites and find zones and about the nature of finds. The other is the integration of data on human activity, including archaeological data, in the EMODnet gateway.[95]

The SPLASHCOS-viewer is the result of input from all nations involved in the SPLASHCOS project, which includes the Netherlands (fig. 14). It was not conceived as a research tool, but, rather, as an information retrieval system that can be used for outreach and management purposes. The map can be queried for archaeological period and a restricted number of specific phenomena, such as 'settlement' or 'grave'. Each data point is associated with information about location, dating, find depth, presence/absence of organic materials, the nature of finds, and references. A glance at the map immediately makes clear to the viewer that major differences exist with regard to the numbers of data points for the various nations. The southern Baltic region has the highest number of data points, and this is directly related to the intensity of underwater surveys conducted by both professional and sport divers, and the relatively easy accessibility of archaeological materials due to shallow waters and good visibility. The North Sea, including the Dutch sector, also has a considerable number of data points, but these are concentrated in the near-coast zone. Data points far offshore are as yet rare, and in the majority of cases, precise locations are unknown. This is, for instance, the case for data points in the Brown Bank area, which correspond to finds trawled up in kilometre-long fishing stretches. Coordinates are 'best estimates', but imprecise. Nonetheless, the SPLASHCOS-viewer is a good step to make otherwise scattered information available to a larger group of professionals as well as interested members of the general public.

[94] http://splashcos.maris2.nl/
[95] http://www.emodnet.eu/human-activities; EMOD stands for European Marine Observation and Data Network.

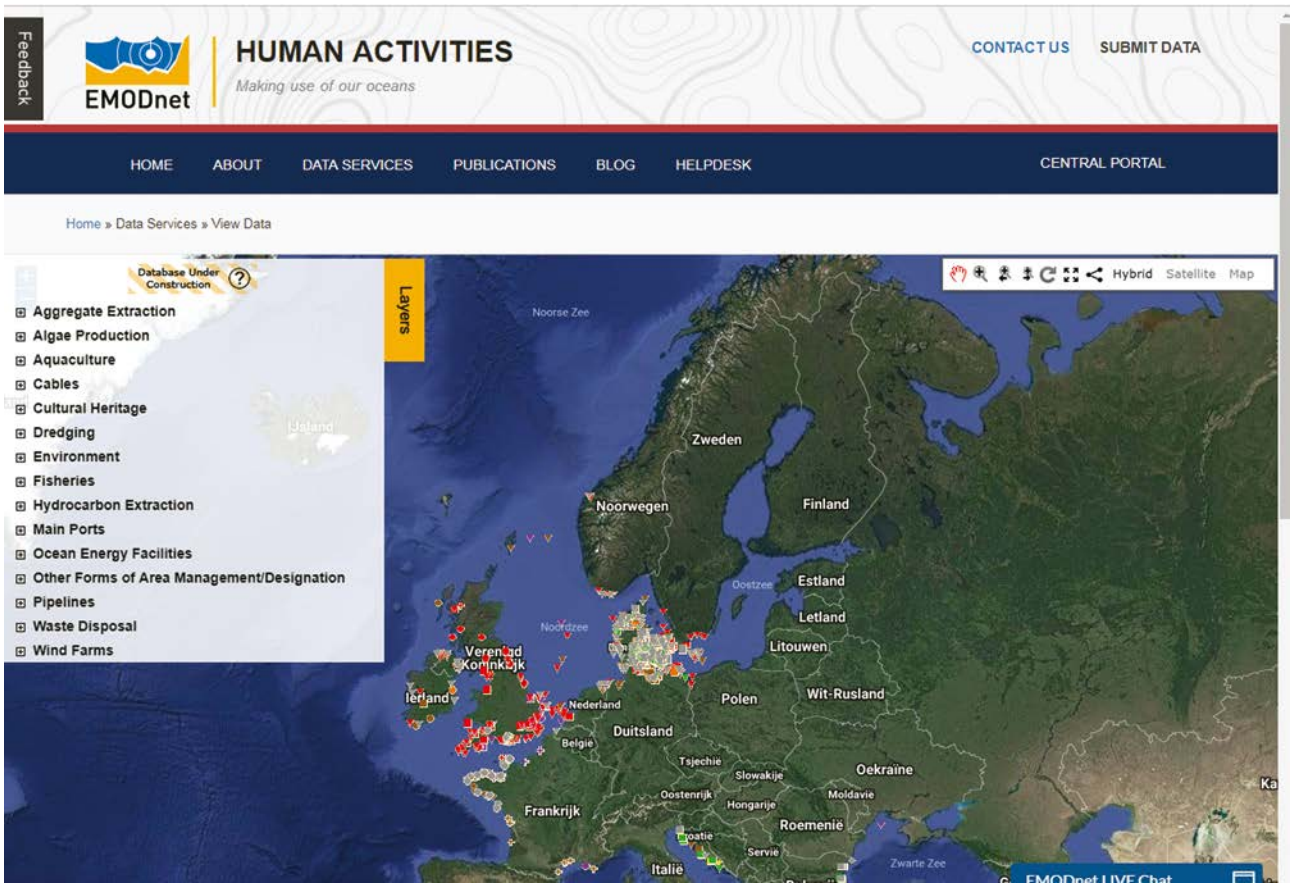

Fig 15 The EMODnet Human Activities portal, with data plotted for prehistoric archaeology.

EMODnet is the gateway to marine data in Europe. Its philosophy is one of 'collect once and use many times', and it depends on the input of many players in the marine field. EMODnet provides a number of portals, each of which collect data in one specific category: bathymetry, geology, seabed habitats, chemistry, biology, physics, human activities, and coastal mapping. The human activities portal provides access to a range of datasets concerning not just present-day activity, but also past cultural heritage (fig. 15). The dataset of prehistoric cultural heritage in fact represents the SPLASHCOS-viewer data. Integration of this dataset in EMODnet ensures the structural embedding of information about submerged prehistoric archaeology in a well-conceived structure. As such, submerged prehistoric cultural heritage is explicitly considered a relevant asset of the marine environment and is made accessible to the many stakeholders in this arena.

4.4 Priority: the spatial definition of research potential and threats

Predictive models have played, and still play, an important role in archaeological heritage management in the Netherlands.[96] On land, from the 1990s until recently, the map of archaeological potential (Indicatieve Kaart Archeologische Waarden, IKAW) provided a nation-wide model of the chances of encountering archaeological materials, indicating where values were high, medium, or low.[97] The IKAW has now been replaced nation-wide by more detailed regional maps and serves management overview rather than management policy. For the Dutch sector of the North Sea, such indicative maps have long been lacking. At the request of Rijkswaterstaat (the Dutch Ministry of Infrastructure and Water Management) an initial map, based on the presence (higher probability) or absence (lower

96 Groenewoudt & Peeters 2006.
97 Deeben, Hallewas & Maarleveld 2002; Deeben 2008; Deeben & Smit 2015.

probability) of basal peat was produced in 2002 (fig. 16).[98]

Offshore basal peat results from Early Holocene marshes, mires, fens, and swamps that, immediately in advance of marine transgression, formed extensively across various types of terrain. The term 'basal peat' is carried over from the onshore context, where such peat it is found below the coastal plain, at the base of the Holocene coastal-deltaic sequence, as a marker bed separating post-transgression deposits ('Holocene') from pre-transgression surfaces ('Pleistocene'). Where it survives, it functions a relatively erosion-resistant bed, due to compaction, often covered by 1-4 m of shelly sand of the active sea bed. Basal peat beds have

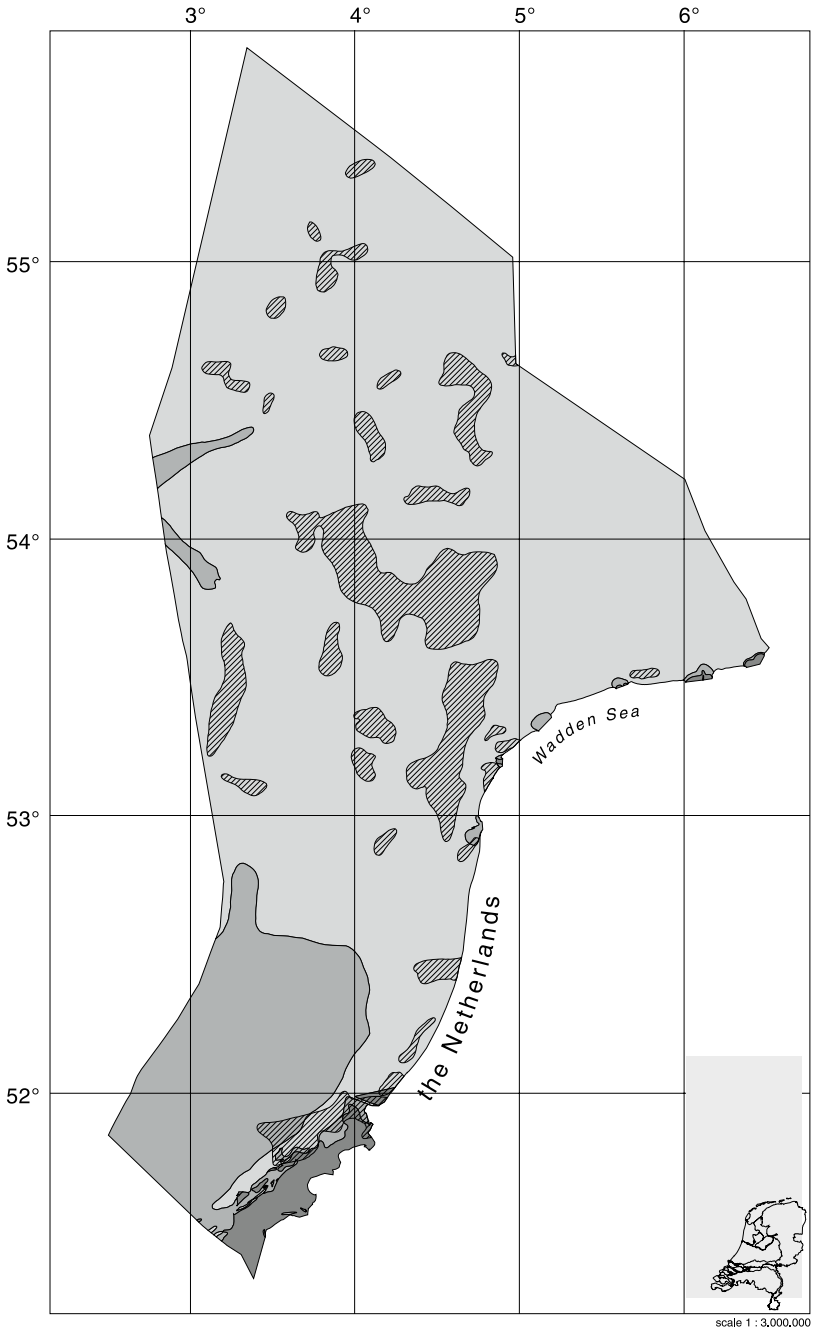

Fig 16 Indicative map of archaeological potential for (pre-)Mesolithic remains based on the presence/absence of basal peat. Dark tones: high potential; shaded: presence of peat and gyttja (after Maarleveld & Peeters 2004, Fig. 14.3).

98 Deeben, Hallewas & Maarleveld 2002.

favourable seismic reflection properties, allowing their mapping using geophysical techniques. Besides being datable and a source for sea-level rise reconstruction (see section 3.2), finding it preserved indicates that the terrestrial surfaces that the peat buried during its formation have also escaped erosion.

Hence, where a bed of submerged basal peat is mapped, the chances of survival of Mesolithic and Palaeolithic remains within and below are higher than where it is eroded. Basal peat mapping therefore provides a fair indication for the potential survival of Mesolithic and Late Paleolithic remains. However, it was realised – in 2002 and in the further studies discusses here – that for indicating absence of prehistoric remains altogether, just mapping extents of basal peat would not do. Archaeological and palaeontological remains dating to the Middle Palaeolithic, for instance, can of course be present in deposits pre-dating the basal peat.

Due to the increase in economic activity in the southern North Sea and new insights with respect to the survival of palaeolandscape structures, several actions have been initiated to develop new spatial models expressing expectations with regard to the potential presence of prehistoric remains. Ward and Larcombe proposed a geogenetic approach to such modelling.[99] A pilot study was conducted to assess the possibility of modelling archaeological expectations by combining such geogenetic information with archaeological expert knowledge (fig. 17).[100] From the test areas selected, it became clear that the variable quantity and quality of geological data resulted in spatial models with highly variable resolution. It was concluded that the development of a predictive model, or 'offshore IKAW', by using a uniform, 'one-size-fits-all' approach would not be feasible, and that several phases of model calibration will need to be gone through to obtain a useable result.

In a follow-up action, efforts were geared at a lithostratigraphical approach to the entire Dutch sector of the North Sea.[101] Drawing on existing borehole information from depths of up to 30 m below the sea floor, spatial models of the distribution of defined lithostratigraphical members and units, as well as sequences (providing information about erosion), formed the basis for an archaeological assessment. The advantage of this approach is that it results in a systematically obtained baseline that informs about sequences of deposits that have their particular geogenetic origin, and that it permits researchers to draw inferences about the potential survival of archaeological contexts dating from different periods. The result is a map that differentiates zones of potential archaeological survival for the main archaeological periods represented within the upper 30 m below the sea floor, notably the Neolithic, Mesolithic, Late Palaeolithic, and Middle Palaeolithic (fig. 18).[102] The map also demarcates zones where no survival is expected, as well as a zone where archaeological potential is possible based on geomorphological features. It is clear, however, that, due to low data density, such models remain extremely coarse-grained and rough estimates at best. Their practical use is therefore limited.

A more fine-grained model of archaeological survival has been developed for the 12 mile zone, which is of particular economic importance for sand extraction (as building material and for beach replenishment). Based on borehole data, a quantitative model with a 250 × 250 m grid cell resolution was calculated for the presence/absence of basal peat, using a sequential indicator simulation, nearest-neighbour interpolation, and ordinary kriging geostatistical modelling.[103] This simulation output was then combined with seismic data, leading to a simplified map with a 1 × 1 km grid cell resolution (aggregated simulation results, prioritized for presence of peat). The preservation of basal peat increases the chances of survival of Mesolithic and Palaeolithic remains within and below the peat. An attempt was made to chronologically specify the archaeological significance by combining this basal peat data with onshore archaeological data. An emerging problem is the fragmented survival of the basal peat (fig. 19). Several zones have been defined on the basis of how these remnants are scattered over an area. Some zones show highly scattered distributions of small patches of peat, while others show larger swaths of peat. The latter are mainly found off Rotterdam and adjacent areas of the coast and off the Wadden isles. A further zone with preserved peat is present off IJmuiden.

Here a problem arises: the uncertainty present in the peat model, notably due to the variable density of reliable observations and the

99 Ward & Larcombe 2008
100 Erkens *et al*. 2014.
101 Vonhögen-Peeters, Van Heteren & Peeters 2016.
102 It should be noted that 'Middle Palaeolithic' in this map also includes Lower Palaeolithic potential.
103 Vonhögen-Peeters, Maljers-Oosterwijk & Peeters in prep.

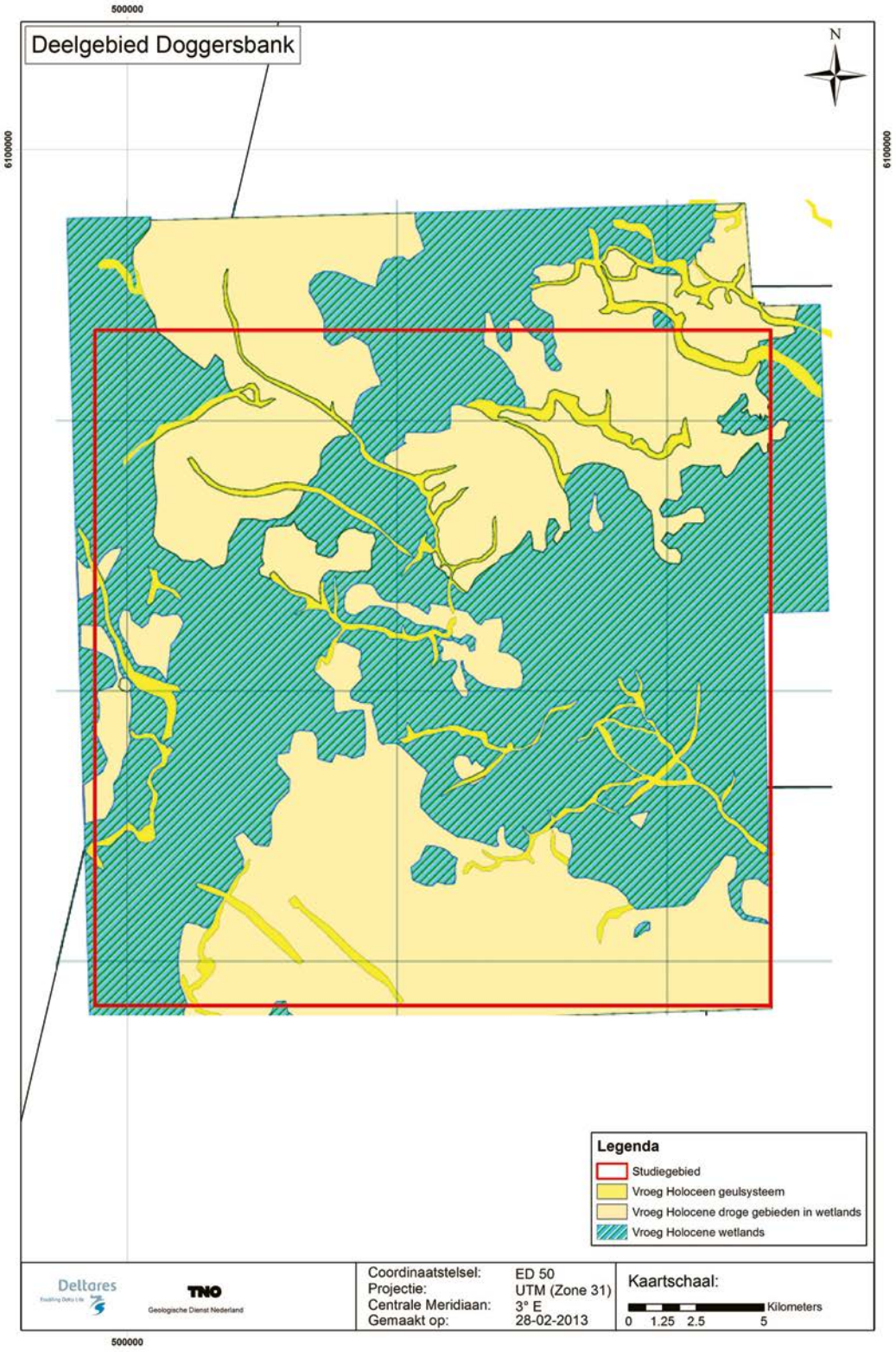

Fig 17 Map of one pilot area (Dogger Bank) showing palaeolandscape features as a basis for the assessment of archaeological potential. Yellow: early holocen gullies/tributaries; beige: early holocene drylands; blue: early holocene wetlands (after Erkens *et al.* 2014, Appendix A, map P).

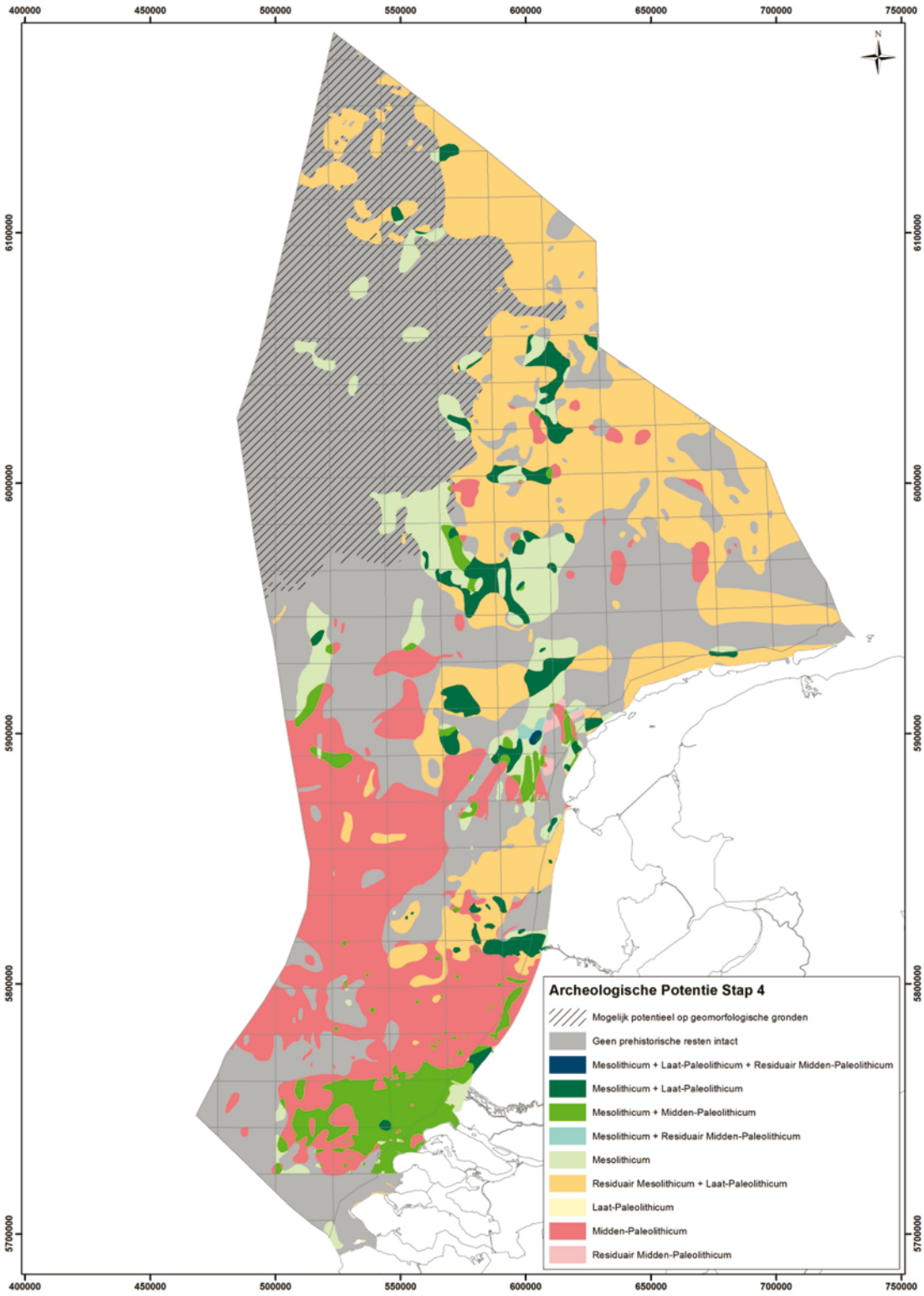

Fig 18 Map showing the preservation potential (in different colours) for archaeological remains dating to various prehistoric periods within the first 30 m below the sea floor. The model is solely based on lithostratigraphical data. The area shown in grey has no potential, but the zone shown in shading has possible potential in view of geomorphological characteristics (after Vonhögen-Peeters, Van Heteren & Peeters 2016, Fig. 4.5).

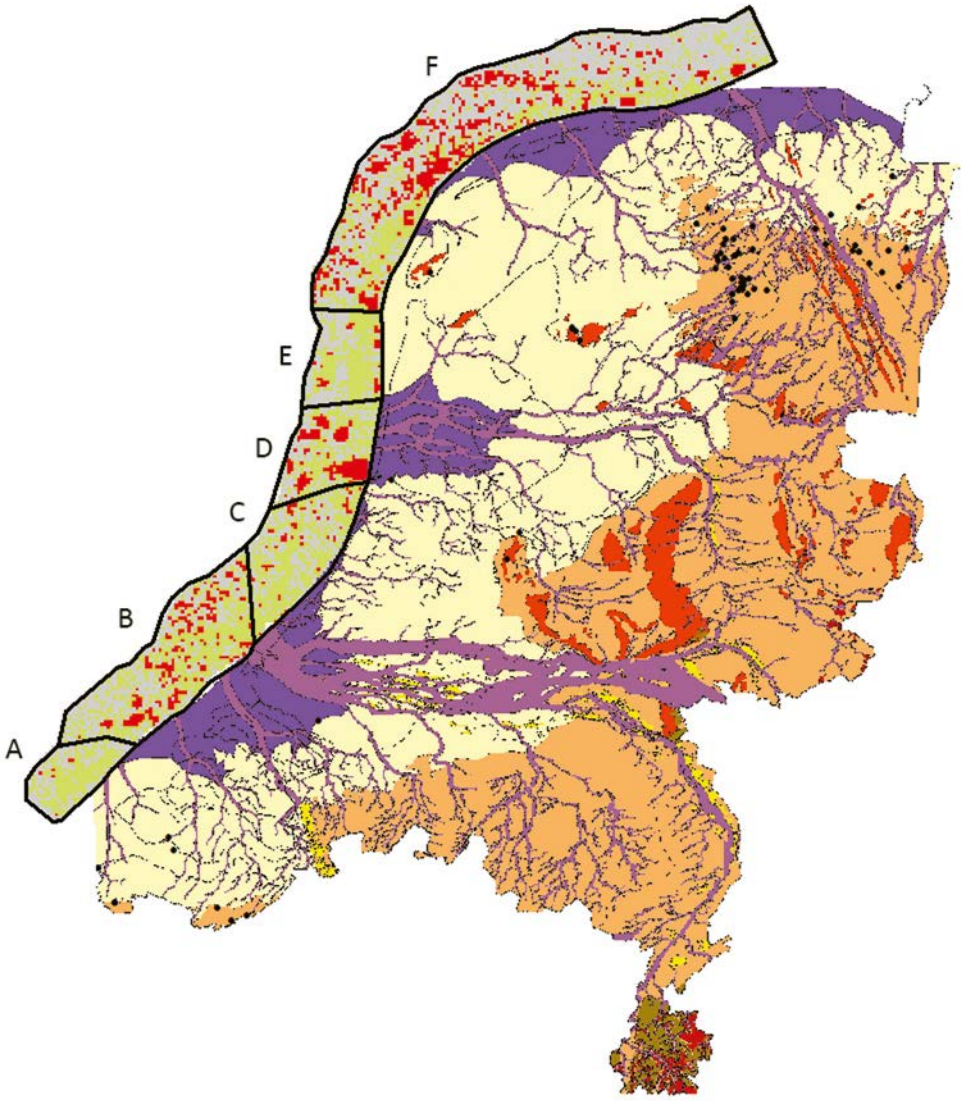

Fig 19 Model of preserved peat within the 12 mile zone. Red: peat present, green: peat absent, grey: presence/absence of peat unknown (after Vonhögen-Peeters, Maljers-Oosterwijk & Peeters in prep.). The map of the Netherlands shows the coversand surface (deep purple <15m below sea level; light yellow: <0m below sea level; dark yellow >0m above sea level), ice-pushed ridges (orange), and stream valleys (purple). Black dots represent Late Palaeolithic sites in the 'near-coast zone' as registered in the national database Archis (sites known further inland are not shown).

vast number of grid cells with unknown presence/absence of peat, due to the absence of observations. This is particularly the case in the zones characterised by scattered, small-sized patches. The question is not just whether or not preservation of peat is indeed fragmentary, but also what 'fragmented' occurrences may represent in the context of landscapes. A high degree of expert knowledge is required to understand the significance of observations and model outcomes, as these cannot be taken at face value. And, just as importantly, absence of peat by no means implies absence of archaeological remains, either in situ or ex situ.

Meanwhile, archaeological landscape mapping and management programmes on land have developed into a multi-layered approach, where the archaeological potential for the Palaeolithic and Mesolithic is separated from that for the Neolithic and subsequent, younger time periods.[104] This development was intimately linked with developments in geological

[104] Groenewoudt & Smit 2017; Lauwerier *et al.* 2017.

mapping, which has moved from borehole-based lithostratigraphical profile-type mapping (burial depth and preservation mapping of palaeosurfaces)[105] to digital, polygon-based geomorphological mapping (storing chronological information of individual landscape elements),[106] to an integration of the two.[107] This integration has allowed archaeological landscape mapping, in which geomorphological and geological features are converted to archaeological potential defined by the expected nature of archaeological manifestations present. The systematics can be applied to the present surface of palimpsest upland and historically reclaimed lowlands,[108] as well as to buried and submerged landscapes of older Holocene time windows.[109]

Researchers projecting knowledge gained on land to little-investigated landscapes offshore must bear in mind the possibility that the archaeological potential of entities onshore is not necessarily the same as that of entities offshore. An important question remains: to what extent is the known onshore archaeological record representative of areas which are now submerged? Spatial (geographical) and chronological differentiation and changes in behaviour may effectively have led to a more variable archaeological output than is currently known.[110]

4.5 Priority: mitigation, conservation, and designation

Mitigation, conservation, and designation are critically dependent on the other two management priorities. This goes particularly for conservation and designation. The conservation and designation of areas or sites is only possible when solid arguments can be given with respect to the particular value of swaths of the seabed or specific locations. In view of the difficulties encountered in research, such conditions are hardly ever met, and in the current situation, interests other than cultural heritage interests will quickly prevail.

In the case of the Maasvlakte 2 expansion of Rotterdam harbour, the (potential) impact of the sand extraction and harbour deepening zones on archaeological and palaeontological resources had been known about for a considerable period of time.[111] The targeted investigation of the harbour basin provided hard evidence for a well-preserved archaeological site, maybe even several sites. The Dutch mining regulations (Mijnbouwwet, 1 January 2003) state that there is an obligation for the offshore industry to take archaeological heritage into consideration.[112] This sets a baseline for mitigation of large-scale disturbances that are directly related to economic activity. However, it was evident that opportunities for arranging in situ conservation or designation of the Maasvlakte 2 as a protected area were zero, given the economic interests at stake. It was therefore decided to focus on the targeted investigation of the areas to be disturbed, and to collect data to permit contextualisation of known finds and possibly expand the archaeological record with new finds collected under controlled conditions.[113]

In view of the number of portals and datasets integrated in the EMODnet gateway, it is very clear that the economic interests in the southern North Sea are enormous. Archaeological work conducted in connection with planned offshore wind farms – including the laying of cables – makes clear that responsibility has been taken, in the sense that the potential archaeological value of designated project areas is being assessed (table 4). But this is a recent development, and, as mentioned earlier (section 3.3), none of these efforts have led to follow-up research or to subsequent agreements about, for instance, financial compensation for loss, to be invested elsewhere.[114]

The chosen approach is paradoxical. Geophysical investigations permit researchers to gain insight into lithological and structural features beneath the sea floor, but these cannot trace archaeological remains. Given the difficulties of tracing prehistoric remains in general, and those in offshore situations in particular, and given the perceived 'limited extent' of disturbance, follow-up is essentially excluded in advance. Hence, palaeolandscape mapping is more or less taken as compensation for the potential loss of (wholly unknown) archaeological data, yet there is no provision for the reprocessing of such data to enhance archaeological insights.

105 Weerts *et al.* 2005; Berendsen 2007; Van der Meulen *et al.* 2013.
106 Berendsen, Cohen & Stouthamer 2001, 2007; Cohen *et al.* 2012, 2014; Pierik, Cohen & Stouthamer 2016.
107 Cohen *et al.* 2014, 2017; Vos 2015; Pierik, Cohen & Stouthamer 2017.
108 Rensink *et al.* 2015, 2017.
109 Cohen 2017; Cohen *et al.* 2017.
110 Cf. Peeters 2007.
111 Glimmerveen, Mol & Van der Plicht 2004, 2006; Mol *et al.* 2006.
112 Maarleveld & Peeters 2004, 112.
113 Manders *et al.* 2008.
114 Of course, follow-up is not necessary in the total absence of indications for the potential preservation of archaeologically relevant remains of prehistoric human behaviour.

4.6 Public outreach

North Sea prehistory has received considerable attention over the past decade (table 6). The media have covered several topics, notably concerning individual finds (e.g. the fragment of a Neanderthal skull, a hyena coprolite, and a decorated piece of bone) and broader issues of submerged prehistoric landscapes or events, such as the Storegga landslide and the subsequent tsunami. In addition, as noted above, the information centre Futureland is aimed at informing the public about the archaeological and palaeontological research conducted in relation to the extension to Rotterdam harbour.

The interest of the Dutch media was triggered by the reporting of spectacular palaeontological finds – notably the fragment of a sabretooth cat dated to the Weichselian[115] – and the results obtained by the University of Birmingham's work on 3D seismic data to reconstruct palaeolandscapes. This was just prior to the NSPRMF expert meeting in Amersfoort in 2008. One question posed was whether and how the precursor of the Rijksdienst voor het Cultureel Erfgoed intended to pay attention to such finds and integrate insights into submerged prehistoric landscapes into its approach towards maritime cultural heritage. This more or less coincided with efforts to bring both onshore and offshore early prehistoric archaeology into the spotlight of archaeological heritage management in a broader sense.[116]

The reporting of further spectacular finds from the North Sea, notably a collection of Middle Palaeolithic hand-axes from British waters (see section 4.2) and a fragment of a Neanderthal skull dredged from the Middeldiep off the coast of the province of Zeeland, boosted broad media coverage (see appendix 1 and 2). The submerged prehistoric archaeological and palaeontological remains and landscapes in the southern North Sea appeal to the imagination of many, maybe because they relate to issues of sea-level rise and its consequences for human populations, a subject that is highly topical in light of climate change. In addition, and without doubt more important, there is an aspect of surprise (sometimes termed the 'Atlantis effect') that there are traces of prehistoric habitation from the sea that was once land and that it is possible to map long-forgotten landscapes by means of modern technology.

Another aspect of this media coverage that is at least as important is that the coverage made clear how non-professional collectors play a key role in the advancement of archaeological insights into the significance of the North Sea for our understanding of the prehistoric past (fig. 20). The vast body of finds is preserved thanks to individuals who spend lots of time, and often considerable money, collecting fossils and artefacts on beaches and from the reject piles of the aggregates industry.[117] These are individuals who also, often pro-actively, inform and interact with the scientific community, enabling the timely discovery of interesting finds. Futureland and its associated activities are also geared at this particular aspect: the possibility of meeting experts (fig. 21), of showing them one's find, and of hearing about what the find is and what it means has proved an enormous stimulus for collectors to go out and look for more and, indeed, report any additional finds to the experts through oervondstchecker.nl. Gradually, we seem to be moving towards a form of 'citizen science'.

[115] See remarks on radiocarbon dating limits in the North Sea in section 3.2. Whether the Weichselian age is a true age is disputed. It is the only sabretooth cat bone from Europe with a Weichselian date. In Europe, the species is otherwise mainly known from cave fills and was last encountered 250,000-400,000 years ago, far beyond the ^{14}C limit.

[116] Rensink & Peeters 2006.

[117] Particular mentions go to the team of North Sea Fossils (www.northseafossils.com) and to amateur archaeologist Jan Glimmerveen. It is important to note that the North Sea Fossils team commercially (but selectively) sells palaeontological objects from the North Sea on a legal basis, the income from which is reinvested to finance trawling expeditions and conservation of fossils. Their website states: 'In recent years fishing methods have evolved drastically due to technological developments and environmental considerations. Traditional trawling methods, in which nets dredge the sea floor, are becoming rare. Most of our fossils are found with exactly this technique, which means that our supply from this source has now been reduced. We are however still finding fossils from sand extracting activities in rivers and old estuaries, which belong to the North Sea realm and share the same characteristics as our traditional fossils. In addition to this, we also organize several dedicated fossil trawling expeditions each year, fishing for Pleistocene treasures in especially fossil-rich areas of the North Sea. Fossils of primary scientific importance are never sold, but are donated by us to appropriate museums, institutes or specialists. Other pieces, which are often still of museum quality, but not so rare or unique to be of the utmost scientific importance, are sold through our website. All fossils sold by North Sea Fossils have been legally procured. All fossils can be freely sold and do not fall under CITES or any other legal restrictions. On request certificates of authenticity and/or provenance can be supplied for all purchases.'

Table 6 Non-exhaustive overview of items in the Dutch media and museums concerning North Sea prehistory.

Medium	Author	Title	Item	Date
Newspaper				
NRC Weekend	Theo Toebosch	Bijvangst	Saber tooth cat fossil	September 2007
De Volkskrant	David Davidson	Op zoek naar de oude bewoners in de zee	Submerged landscape and archaeology	2008
NRC Next	Theo Toebosch	De laatste jagers in Doggerland	Prehistoric finds from the North Sea	September 2016
Leidsch Dagblad	Wilfred Simons	Rijke verleden van Doggerland	Submerged landscape and archaeology	October 2015
NRC Next	Theo Toebosch	De taaie laatste jagers op het land dat Noordzee werd	Isotopic evidence hunter-gatherer diet	November 2016
Leids Nieuwsblad		Archeologen ontdekken het 'Doggerland-menu'	Isotopic evidence hunter-gatherer diet	November 2016
NRC Weekend	Hester van Santen	De zoekers naar het verzwolgen Noordzeeland	The search for Doggerland	April 2017
>20 newspapers, including NRC/De Volkskrant/Trouw en Leisch Dagblad	Based on press release		Late Palaeolithic art and human remains	February 2018
Leidsch Dagblad	Rob Overmeer	Het DNA van een Katwijkse kaak	DNA from a Mesolithic human mandible	July 2018
De Volkskrant	Maarten Keulemans	Met stukjes mens naar het museum	Report on expertise day prehistoric human remains North Sea	November 12th 2018
Radio				
Radio 1			Late Palaeolithic art and human remains	February 2018
2DOC VPRO radio	Matthijs Deen	De eerste Europeaan	Older Palaeolithic hominin dispersals	2014
Television				
News/Talk show	De Wereld Draait Door	Maasvlakte 2	Hyena coprolith from Maasvlakte 2	9-12-2010
Documentary	National Geographic	Stone Age Atlantis	Drowning of Doggerland	2010
Documentary	BBC Horizon	First Britons	Drowning of Doggerland	2015
News	NOS Journaal		Oldest modern human and art from the North Sea	13-2-2018
News	NOS Jeugdjournaal		Oldest modern human and art from the North Sea	13-2-2018
News	TVWest		Oldest modern human and art from the North Sea	13-2-2018
Popular Book				
Rap, Amsterdam	Matthijs Deen	Over oude wegen	Older Palaeolithic hominin dispersals	February 2018
Magazine				
Elsevier	Simon Rozendaal	Onze sabeltandtijger	Fossil fishing on the North Sea	September 2007
Natuur, wetenschap & techniek	Theo Toebosch	Het lage land dat verdween	Drowning of Doggerland	October 2007

Medium	Author	Title	Item	Date
New Scientist	Laura Spinney	Where are the bodies?	Why don't we find graves?	November 2008
National Geographic Magazine	Laura Spinney	Searching for Doggerland	What happens when people lose their homeland	December 2012
National Geographic Magazine	Tessa Guntlissbergen	Oudste stukje mens	Oldest modern human and art from the North Sea	May 2018
Internet				
Blogs	TNO/Deltares/NIOZ	Hidden secrets in the North Sea	Reconstructing sea-level rise	July 2017; July 2018
Youtube	TNO/Deltares/NIOZ	Hoe is de Noordzee ontstaan?	Sea-level rise and 'birth' of the North Sea	October 2017
Newsweek	Dana Dovey	Early humans: 13,500 year old bison bone with mysterious carvings discovered at bottom of the North sea	Oldest modern human and oldest art Netherlands / North Sea	February 2018 (https://www.newsweek.com/early-humans-13500-year-old-bison-bone-mysterious-carvings-discovered-bottom-813875)
Fox News	James Rogers	'Oldest Dutchman' discovered: Fishermen find prehistoric skull in North Sea	Oldest modern human and oldest art Netherlands / North Sea	February 2018 (https://www.foxnews.com/science/oldest-dutchman-discovered-fishermen-find-prehistoric-skull-in-north-sea)
NOS		Oudste Nederlander uit de ijstijd gevonden	Oldest modern human and oldest art Netherlands / North Sea	February 2018 https://nos.nl/artikel/2216920-oudste-nederlander-uit-de-ijstijd-gevonden.html
LiveScience	Tom Metcalfe	Ancient Human remains from beneath the North Sea	Oldest modern human and oldest art Netherlands / North Sea	February 2018 https://www.livescience.com/61880-oldest-dutchwoman-photos.html
Museum				
RMO	Amkreutz	Vuistbijlen uit de Noordzee	Exhibition on the Meulmeester find of hand-axes and associated tools	2008; RMO
RMO	Amkreutz	Eerste Nederlandse Neanderthaler	Exhibition on the first Dutch fossil find of a Neanderthal	2009; RMO
RMO	Amkreutz	Archeologie van Nederland	First two exhibits in the permanent exhibition of the Archaeology of the Netherlands feature the North Sea and prehistoric North Sea archaeology	2011-present; RMO
RMO	Amkreutz	Archeologie van verdronken prehistorische landschappen Noordzee	Planned exhibition, possibly traveling on drowned prehistoric North Sea archaeology	2020/21; RMO

Fig 20 Front page of the science quire of the *NRC Weekend* edition of the national newspaper *NRC*, which devoted four pages to the activities of collectors and scientists under the title heroes of the North Sea land.

Fig 21 Meeting the experts: private collectors show their finds to professionals (photo courtesy of L. Amkreutz, RMO).

4.7 Conclusions

With respect to the NSPRMF 2009 management agenda, a range of initiatives has been taken. Some initiatives have permitted steps forward, whereas others have made it clear that much remains to be done in order to firmly anchor archaeological interests concerning submerged prehistoric archaeology and landscapes in heritage management policies – and in order to develop regulations as well as strategies.

Collaboration with industry and private collectors has been variably successful. In the context of the Rotterdam-Maasvlakte 2 harbour extension, efforts have led to a strategy that was beneficial for both the scientific community and the economic stakeholders, which involved finding solutions for research opportunities within a highly complex project. Within the same setting, activities focussed on public outreach spurred collaboration among the developer, scientists, and private collectors. This triggered further initiatives aimed at structural collaboration between scientists and private collectors and the recording of finds. The case study of the Area 240 Palaeolithic hand-axes, as well as that of the Middeldiep Neanderthal skull fragment, however, show that collaboration with industry can easily become disrupted due to conflicting interests.

The systematic recording of finds made by private as well as professional collectors forms an important basis for data sharing. The SPLASHCOS-viewer, which provides basic information about the location and nature of archaeological and palaeontological finds, forms a platform that permits further data sharing. Importantly, the SPLASHCOS-viewer database has been integrated into the EMODnet gateway, thereby making prehistoric cultural heritage a relevant aspect of the marine environment that is made available to a wide array of stakeholders.

Increasing data availability is highly relevant and desirable for the assessment of research potential and threats. Initiatives have been taken to model potential for the presence of prehistoric archaeological remains in the Dutch sector of the continental shelf. These models are coarse-grained due to the relatively low density of geological data on which they are primarily based, and a high degree of expert knowledge is needed to understand and interpret model outcomes. Risk assessments are constrained by the coarseness of the models, which do not permit researchers to evaluate research potential and threats at the scale of individual spatial developments. This limitation hinders pro-active approaches to mitigation, conservation, and designation. The sparseness of good data points makes it difficult, if not impossible, to explicitly make clear which archaeological interests are at stake. As a consequence, geoarchaeological assessments of individual project areas lead to generic designations of zones of potential archaeological interest, without any follow-up to test the validity of the believed potential.

This leads to a paradoxical situation. Many exiting finds continue to be made, and these attract a lot of media attention; they are the hard evidence of human presence in a landscape that has become sea. Public outreach activities have been very successful. But whereas such finds spark the imagination of a broad audience, they have not (yet) led to the establishment of a management approach that demands serious research to move from assessing potential to model testing and observation.

The NSPRMF 2009 priorities were particularly focussed on one of the management themes, notably 'Assessment and data sharing'. With regard to data sharing and finds reporting, major steps have been taken, and these should be continued. The same goes for collaboration with private collectors. Although not originally defined as a priority, public outreach has been very successful, and activities should be continued and expanded. Other topics and themes, however, need further attention.

5 Towards a new agenda: opportunities, dilemmas, and choices

5.1 Introduction

The NSPRMF 2009 defined a broad set of research and management themes and topics for which the southern North Sea was deemed to be of relevance. Several priorities were identified with respect to research and management. The preceding chapters have provided an evaluation of the framework focusing on the Dutch sector of the North Sea, answering the question 'Where do we stand after a decade of work?' The conclusions to chapters 3 and 4 make clear, on the one hand, that progress has been made with respect to a number of issues and, on the other, that a lot remains to be done. At present we are still far from a situation where priorities are met, in the sense that insights obtained permit the setting of new priorities that can build on these insights. This implies that the themes and topics of the NSPRMF 2009 (tables 1 and 2) remain topical and relevant.

In this final chapter, suggestions are made how to move forward in the coming years within the context of archaeological heritage management in the Netherlands. This chapter can serve as a basis for the development of further (or new) strategies, not necessarily only in the Dutch context. *Position Paper 21 of the European Marine Board* can be taken as a baseline for a cross-national perspective, being based on an EU-wide assessment of achievements, challenges, and problems and an understanding of data resources and available research technology.[118]

5.2 From potential to new good data points

The vast majority of work conducted is strongly focussed on the registration and publication of stray finds, as well as the mapping of lithological sequences and identification of palaeolandscape (geomorphological) structures. The results corroborate existing insights with respect to the enormous archaeological potential of the Dutch sector of the North Sea. The analysis of finds either lacking or having only limited stratigraphic and palaeoenvironmental context underscores their scientific value, in that, on the one hand, they bear intrinsic information and, on the other, they aid in the evaluation of the representativeness of the overall archaeological record. The combination of geophysical research, geogenetic interpretations, and dating of lithostratigraphical sequences provides insight into the potential origin of such finds, as well as useful data for palaeogeographical reconstructions.

However, registration and analysis of ex situ finds also has its limits, most certainly with respect to strategic decision-making. The much-needed increase in high-quality data points cannot come from such finds alone, no matter how interesting the results of analytical results may be. To validate geoarchaeological assumptions warranting strategic decision-making, the establishment of context of chance finds occurring during and after the execution of offshore infrastructural works, collecting data from purposely selected locations is a necessity.

The work conducted in Area 240 to obtain insight into the original context of the Middle Palaeolithic artefacts collected from a reject pile at a wharf in Flushing demonstrates how this can be achieved.[119] The results obtained in the context of the site of Rotterdam-Maasvlakte 2 provide an example of how a well-thought-out strategy can deliver contextual information for finds collected on artificial beaches prior to, during, and after the construction of the new harbour.[120] Critical analysis of existing geological data can permit additional contextualisation of stray finds, such as has been done for the Middeldiep Middle Palaeolithic finds.[121] At the same time, it should be mentioned that these are sparse examples that came about in a specific setting, i.e. the elaborate Rotterdam-Maasvlakte 2 programme and the assertive operating possibilities of English Heritage.

We should bear in mind that the situation for the Netherlands is not that different from that in Great Britain. There, too, little targeted in-depth research has been conducted.[122] Whereas the Dutch tend to take British projects as an example of what can be achieved, British colleagues do the reverse, taking Dutch projects as examples.[123] As of recently, the potential for submerged prehistoric remains is being considered in impact/risk assessments for offshore economic developments. But as yet, this has not led to new good data points. There

118 Flemming *et al.* 2014.
119 Tizzard *et al.* 2011.
120 Kuitems *et al.* 2015.
121 Hijma *et al.* 2012.
122 Compare e.g. Bynoe (2018) and Sturt *et al.* (2018).
123 See e.g. the reviews of the Maasvlakte 2 research report by Innes (2015) and Firth (2016).

Table 7 Various stakeholders have different interests.

Stakeholder	Interest
scientists	analysis and modelling; scientific knowledge
developer	accountability of investment; positive press
heritage managers	significance assessment as a basis for policy making
decision makers	informed knowledge
public	evidence-based narratives

is much to gain here by involving more experts in sampling and in the interpretation of seismic and borehole data. The same holds for the selection of sample locations and planning of seismic investigations. To achieve this involvement, it will have to be forced upon in the early stages of project design.

In order to maximise the archaeological value of work to be conducted especially in the forthcoming years, particularly in the context of development-driven projects, it will be necessary to better define what constitutes a 'good data point' and to better define how useful results for archaeology can be obtained within the existing framework. From an archaeological perspective, a good data point involves the georeferenced results of a consistently conducted analysis of observations/recordings (whether geological, palaeoenvironmental, or archaeological) of which the archaeological relevance is explicitly made clear. This forms the basis for the management of the expectations and demands of funders, both the developers and the funding bodies for research.[124]

Good data points are necessary not just for the discipline of archaeology itself, but also for developers, heritage professionals, decision makers, and the general public (table 7). As pointed out in section 3.3, geophysical investigations in the context of recent economic developments have not seen any follow-up, for various reasons. The results themselves are of limited archaeological value, since no data have been collected that might allow researchers to actually say anything about the presence or absence of archaeologically relevant phenomena, or even landscape if defined more broadly than just an assemblage of geomorphological features (see section 4.5). At some point, developers will wonder why such investments are being required of them.

Heritage managers, for their part, need good data points for significance assessment and policy making; in the long run, saying that an area has 'potential' will no longer suffice. They also need good data points for decision-making, because this involves risk management, and risk management is predicated on reliable information or informed knowledge. And in the end, good data points are needed for all stakeholders to move from speculative narratives towards evidence-based narratives.

5.3 Strategies and techniques

The collection of good data points and the availability and choice of prospection or survey techniques are manifestly closely related, as are management issues of project planning and budget negotiation, and site location (e.g. near vs. far offshore, water depth, disturbance depth). Prehistoric remains in the Dutch sector of the North Sea date to the Stone Age. Human activity from this time period is by definition difficult to detect. The British approach to offshore projects is mostly to apply grab sampling. Core sampling is typical of the 'Dutch approach' to the detection and identification of prehistoric 'sites' onshore, where it is also a default choice in soil, geomorphological, and geological mapping (dubbed 'physical geographical investigation' in the Dutch archaeological sector). As such, using cores has been 'copied' to the offshore situation. The application of sub-bottom profiling for offshore archaeological risk assessment in development areas seems to have become routine.[125]
Sub-bottom profiling is an established marine investigation technique also because geophysical surveys are much easier to execute over vast water surfaces than on land. This

[124] Sturt *et al.* 2018.
[125] Besides purposely collected shallow sub-bottom geophysical data in current projects (examples on offshorewind.rvo.nl), archaeological research groups (Bradford: Europe's Lost Frontiers; Gaffney *et al.* 2017) and national geological surveys also make use of reprocessed legacy seismic data, gathered in past projects and originally targeted at mapping features at intermediate depths.

technique was routinely deployed and as such adopted in drowned landscape geoarchaeological mapping.[126] To what extent current use of the marine geophysical surveying and coring campaigns is technically effective and strategically sufficient for offshore archaeological research and prehistoric heritage management will be discussed below.

Coring may help in detecting potentially interesting landscape contexts and layers for bulk sampling; (slopes of) river dunes, for instance, carry 'dirty' occupation layers, which are better observable. Coring also provides access to materials suitable for dating and palaeoenvironmental reconstructions. The detection of prehistoric archaeology by means of core sampling is highly problematic, in particular with regard to early prehistoric (i.e. Stone Age) sites. Although core sampling is routinely practised onshore, it is clear from years of development-driven work that early prehistoric sites often escape detection by this method.[127] A quantitative assessment of the effectiveness of core sampling to detect Stone Age sites consisting of scatters of materials (mostly flint) with variable density has shown that only extended, high-density scatters stand a reasonable chance of being discovered,[128] and that discovery requires a dense sampling grid (20 × 25 m), a large auger diameter (12 cm), and a small sieve mesh size (3 mm).[129] With decreasing density and extent of the scatters, even denser sampling grids are required. A 'best practices' approach such as this, which has been proven problematic to apply even onshore,[130] appears to be unsuitable offshore, because core sampling for the purpose of retrieving the flint artefacts or other occupation debris typical of Stone Age sites will be ineffective due to the fact that the core sampling grid will always be wide because of financial restrictions, and sample volumes will always be restricted as a result of small auger diameter. Any discovery of such materials in a core sample is basically a matter of coincidence. To establish whether or not prehistoric remains are present in a zone of high archaeological potential, large-volume (i.e. grab) sampling, which is destructive, is the only option. Cores can help to decide where to place the grab samples.

Sub-bottom profiling is certainly useful, but it represents just one technique for collecting data that can be used for palaeolandscape reconstructions, notably mapping of past land surfaces. Sub-bottom profiling is not intended to detect archaeological sites/phenomena, but, rather, to obtain insight into stratigraphic buildup and geomorphological structures beneath the sea floor. This profiling may help in determining whether or not there is a potential for prehistoric remains to be present, or, put differently, whether or not there is a risk of encountering such remains when disturbing the sub-soil. Seismics and other sub-bottom techniques are useful to map and trace buried land surfaces (e.g. underneath basal peat reflectors), as well as erosional contacts (channel bases). Combined with coring, land-surface mapping can be far more powerful offshore than on land. It should be noted though, that the mapping of ancient land surfaces alone does not constitute palaeolandscape mapping. Palaeolandscapes must be reconstructed on the basis of interpreted data (among which seismic data), and this data involves more than just the physical features of ancient land surfaces, including, additionally and notably, the reconstruction of vegetation and fauna, soil conditions, and hydrology. Also, whereas seismics can reveal stacked and intersecting landforms allowing the inferring of relative age and depths of features and hence allowing correlation to sea-level curves, they provide no means of numeric age control. Seismics can be used to identify optimal location for cores to sample for dating. Lastly, it is necessary to note that palaeolandscape reconstructions are only meaningful to archaeology if these permit the drawing of inferences about, for instance, prehistoric land-use variability and taphonomic processes.

The above critical remarks are meant to draw attention to the limitations of routine application of 'established' techniques. A wide range of technologies exist that could be used in the search for submerged prehistoric archaeology and research of landscapes (fig. 22).[131] The key issue here is that the choice of specific technologies is a matter not just of technical/condition requirements for their application in relation to the conditions in the zones targeted, but also of scale and objective (fig. 23). Geophysical and remote sensing technologies, which are principally used in the context of landscape mapping, are particularly suitable for that purpose as they are

126 Sub-bottom profiling is a stepped technique which involves geophysical data collection, noise suppression, time-depth conversions of the raw signals, and overlaying geological interpretation on the processed data.
127 Peeters *et al.* 2017.
128 Verhagen *et al.* 2013.
129 Verhagen *et al.* 2013, 246, table 8.
130 Peeters *et al.* 2017.
131 Flemming *et al.* 2014; Missiaen, Sakellariou & Flemming 2017.

METHOD	TECHNIQUE	TYPE OF DATA	TECHNOLOGY
REMOTE SENSING	Acoustic	Seafloor map	Side-scan sonar, multibeam echosounder
	Acoustic	Sub-seafloor image (2D)	Sub-bottom profilers
		Sub-seafloor image (3D)	3D Chirp, SES-2000 Quattro
	Lidar	Seafloor topography	Airborne Lidar Bathymetry
	(Electro-) magnetic	Seafloor and sub-seafloor magnetic/resistivity map	EM profilers, gradiometers
DIRECT INVESTIGATION	Coring and sampling	Sedimentological/environmental	Grabs (van Veen, Shipek) Boxcore, vibrocore, gravity core, piston core
	Dive surveys	Sedimentological/archaeological	Swim dive (corridor/jackstay/circular)
			Drift/contour dive
			Excavation
UNDERWATER PLATFORMS	Submersibles (manned/unmanned)	Wide spectre of data (acoustic maps, water/sediment samples, cores, video, ...)	HOV, ROV, AUV
PHOTOGRAPHIC	Photo, video, stereo	Exposed seafloor	Digital 2D/3D cameras, photo/video-mosaicing, video microsope

Fig 22 Diagram showing the wide range of technologies that can be applied in research into submerged prehistoric archaeology and landscapes (after Missiaen, Sakellariou & Flemming 2014, Fig. 2.3).

non-invasive and permit researchers to cover large areas in a small amount of time. Sampling technologies are used in the context of site detection and significance assessment, but these are invasive and time consuming.

An obvious question that arises is whether geophysical and remote sensing techniques are suitable for archaeological prospection. The answer to this question is not a simple 'No'. For the detection of materials surfacing on the sea floor, the use of remotely operated vehicles and autonomous underwater vehicles equipped with high-resolution cameras (sub-bottom, swath bathymetry)[132] allows for targeted surveying of the sea floor at greater depths. As yet, no such work has been done in the southern North Sea, but examples from the Baltic Sea area demonstrate the potential of such technology.[133]

It is timely to deploy these techniques as part of investigation in the North Sea, too. However, the availability of high-tech equipment is not sufficient; without clearly targeted areas, the chances of finding anything relevant are slim, but come at a high costs.[134]

In principle, high-resolution (in the order of 10 cm) sub-bottom profilers permit the registration of small-sized subsoil disturbances, such as burial pits and even pit hearths. The biggest problem here is how to identify such phenomena in the 'tsunami' of data produced. Ground-truthing of larger-scale geological features by means of coring is relatively easy, but targeting small-scale archaeological features (those measuring only a few m^2 at most) is problematic, and maybe even unrealistic, notably due to imprecisions in geo-referencing seismic lines.

[132] See Flemming *et al.* (2014) for an overview of available techniques.
[133] See e.g. Hansson *et al.* 2016.
[134] An frequently heard complaint regarding the North Sea is limited underwater visibility due to murky and turbulent waters. Recently made underwater video records of the sampling of basal peat (see section 5.3) demonstrate that this view is an over-simplification and that visibility can surpass 10 m (personal communication F. Busschers and M. Hijma, November 2018).

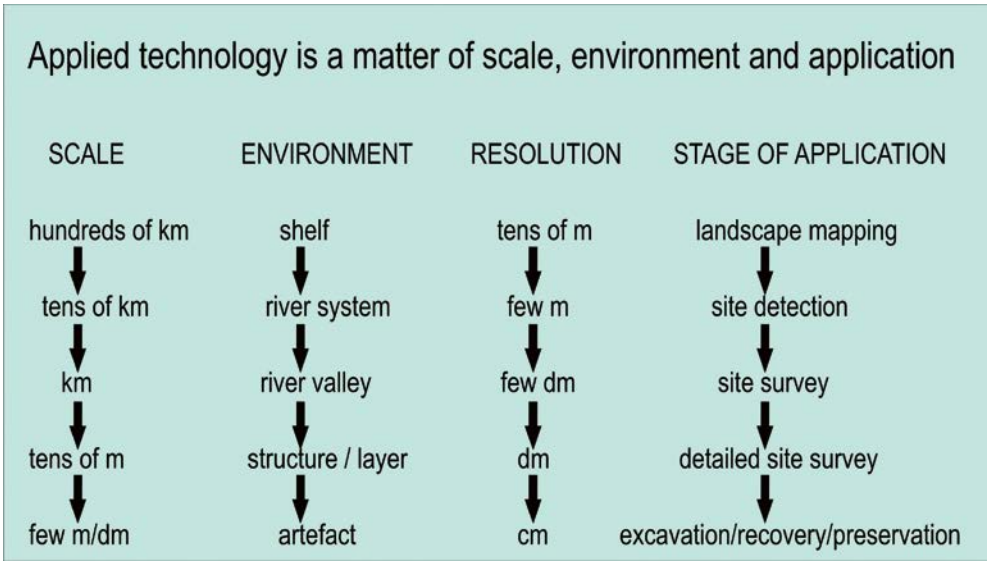

Fig 23 Diagram showing the connection of technology to scale, environment, and application stage (after Missiaen, Sakellariou & Flemming 2014, Fig. 2.2).

Well-conceived protocols and strategies need to be developed in connection with the specific opportunities offered by offshore developments. Routine application of technologies,[135] no matter how powerful they may be in and of themselves, bears the risk that time and money will be invested in a technology that does not provide archaeologically useful results in the short term. More tailored application – optimized to the type, size, and execution pace of the project, as well as to the archaeological expectation (suspected site taphonomy) and palaeoenvironmental context – is to be favoured if better results are to be obtained. Tailored approaches involve that a successful approach and result in one project, cannot be directly copied over to next projects. However, the successful, staged approach and engineering solutions at Rotterdam-Yangtzehaven are not simply adapted to other projects. Each project differs in character with respect to planned disturbance of the seabed, construction requirements, and economic-political context, and not every project will offer the same scientific opportunities in relation to the NSPRMF research agenda. The starting point for the development of a research strategy at the project level should therefore be which questions we *want* to answer (with the NSPRMF providing the scientific guideline) and which questions we *can* likely answer in the specific context of the project (applicability of techniques, nature/context of the planned development).

5.4 Collaboration in research

Sharing data and expertise is a necessity if we are to move beyond 'potential' and if we are to avoid a loss of continuity.[136] The aspect of continuity is one to take into serious consideration, because the research and management community in the field of submerged prehistoric archaeology is small, and therefore even minor changes in this population due to developments in personal careers make it difficult to maintain momentum.[137] Loss of continuity results in a decline in achievements and expertise, inevitably leading to reidentification of problems and 'reinvention of the wheel'. As a consequence, the focus will remain on the defining of potential, instead of the testing and validating (materialising) of potential. It is therefore necessary to take supportive measures that can foster collaborative structures beyond those of temporarily financed projects with restricted duration – let alone unfunded projects that rely on the enthusiasm of the researchers and amateur archaeologists/palaeontologists involved.

For such structures to emerge, effecting synergy of existing capacities may prove the most effective at this point. An example of how this can be established can be given here. In

[135] Sturt, Dix & Grant 2017.
[136] Sturt, Dix & Grant 2017; Sturt *et al.* 2018.
[137] Salter, Murphy & Peeters 2014; Sturt *et al.* 2018.

2016, TNO-Geological Survey was asked to send in a research proposal that would make use of free ship-time of the Dutch research vessel *Pelagia* (see section 3.3). This led to a joint proposal by TNO-Geological Survey and Deltares focussed on offshore mapping and sampling of peat for the reconstruction of Holocene sea-level change.[138] Their first expedition took place in 2017.[139] At the same time, the Flanders Marine Institute and Ghent University had been planning an expedition (for 2018) involving sub-bottom mapping of specific target areas in the southern North Sea, notably the Brown Bank area, making use of free ship-time of the research vessel *Belgica*. In order to maximize their research efforts and the ship-time available, these two expeditions joined forces in 2017, with additional involvement of academic institutions and specialists (University of Bradford, University of Groningen). Further expeditions were conducted in 2018, visiting Brown Bank and Dogger Bank. With respect to the latter area, contact with the leading German institute for coastal research (Niedersächsisches Institut für historische Küstenforschung Wilhelmshaven) was revived and may lead to further collaboration.

Management-wise, the benefits of this informal collaboration was to share information, collectively select target areas for sampling, make use of each other's equipment for sampling, and share cores for laboratory sampling. It is hoped that, ultimately, the outcome of this work will permit targeted archaeological prospection of areas that are known to have delivered archaeological materials (artefacts made out of stone and bone/antler, as well as human remains). An important question is how this synergy of capacities can be maintained. The participating researchers (13 in total) are all connected to established institutions, mostly financed by their respective states. The research vessels also belong to national institutions, which allocate the ship-time funds. Grant money (universities), programmatic budget reservations (knowledge institutions), and strategic investments (both) finance the post-cruise research costs: cool storage, sampling, lab analysis, temporary-employment salaries. To foster the established partnerships, efforts could, for instance, be geared at an inter-institutional memorandum of understanding on geological, palaeoenvironmental, and archaeological work in the North Sea, writing down the terms of free exchange of equipment, staff, and ship-time, as well as sharing and management of data. Even a cross-national 'centre for North Sea prehistoric environments' could be envisaged. Such a structure would also benefit cultural heritage bodies, which would be able to count on expert knowledge.

Cooperation between researchers working on submerged sites and researchers working on the analysis and publication of stray finds and their potential is also important, as a combined approach will have the most impact and support. For researchers to be effective at communicating the importance of what happens 'out there', the stakeholders, including the general public, need to be aware of what the research is about. For instance, the hand-axes found at the wharf at Flushing have triggered research in extraction Area 240 in the British part of the North Sea that has high scientific impact – also because this particular offshore area connects to cliffed coastal sections of Suffolk and Norfolk with rich Middle and Early Palaeolithic archaeology. As another example, the results of the isotope study on human remains, which are all stray finds, underlines the value of the North Sea concerning the topic of human responses to climate change. Identified submerged sites and stray finds provide complementary datasets and should therefore be used in a complementary fashion in research.

5.5 Management and industry

Dialogue and collaboration with industry have long been identified as being of central importance for research into the prehistoric past of the southern North Sea and, indeed, any other parts of the European continental shelf.[140] However obvious this importance may be, the practical side of it continues to be a matter of concern. The Rotterdam-Maasvlakte 2 and Rotterdam-Yangtzehaven archaeological projects became a success, but only because of continued dialogue, mutual understanding, and a shared sense of responsibility. In view of the unknown outcome and lack of experience, these projects were set up as an 'experiment'; within the limits of what was realistic (see section 4.2),

[138] The project was partly funded by the Rijksdienst voor het Cultureel Erfgoed.

[139] https://www.deltares.nl/en/blog/hidden-secrets-north-sea/; https://www.deltares.nl/en/blog/improving-projections-of-future-sea-level-rise/; https://www.youtube.com/watch?v=wSqfUnfKs2Q.

[140] Flemming 2004; Peeters, Murphy & Flemming 2009; Flatman & Evans 2014; Flemming *et al.* 2014; Salter, Murphy & Peeters 2014; Sturt, Dix & Grant 2017; Sturt *et al.* 2018.

risks were taken, as if those involved were probing a black box. Gradually, uncertainty made room for enthusiasm on the part of the funder and the heritage bodies and scientists involved. Engineers from the constructing company PUMA sought solutions to problems of above-water investigation of underwater archaeological layers. And the spectacular results could be turned into a success story in the eyes of a broad audience of professionals and non-professionals. This also formed a much valued opportunity for the Port of Rotterdam harbour authorities to attract media attention in a positive way, as a responsible organization.

Just like onshore developments, offshore developments involve many stakeholders, each with their own interests. Each project comes with a different composition from among the overall group stakeholders, and the cards are reshuffled. The obvious problem here is a lack of continuity, in that interests need to be clarified, discussed, and negotiated each and every time. But this cannot be avoided. A question that is sometimes raised is whether 'the industry' is willing to pay attention to prehistoric archaeology. We would point out that 'the industry' is not a monolith: it is diverse in its nature and goals, and there are many players in the field, having different responsibilities and taking different risks. Having insight into the diversity present within the industry, and the responsibilities and risks faced by the industry, will undoubtedly help those approaching this same industry. This insight will also help to clarify archaeological interests, which come with their own responsibilities and risks. The industry's attitude towards archaeology largely depends on how the archaeological community delivers its message, and this, of course, is a matter of communication.

Despite all the complexity of the project and all the interests at stake, the Rotterdam-Maasvlakte 2 project was perhaps relatively easy, in that the Port of Rotterdam harbour authorities was the leading party at the negotiating table. Other offshore developments, notably aggregate extraction and construction of wind farms, involve many different initiatives that are more or less developed in isolation, although they are mostly part of broader national policy and result from political decision-making. All of these initiatives have to reach their goals, within a myriad of regulations and economic targets. Risk management is at the fore, and industry will abandon any intervention that may lead to problems, as quickly as possible. Mostly, when it comes to archaeology, uncertainty about lead time and costs causes the biggest problem. This uncertainty, however, is created by the archaeological community itself, as it does not speak with one voice and apparently finds it difficult to make choices. Certainly, we do not possess well-tested research frameworks with which to calculate, monitor, and evaluate costs, impact, and output. However, we must move away from 'We don't know what to expect and what should be done' and towards 'This area permits this type of investigation, and this is what we want to focus on'.

In order to successfully communicate within this particular context, it is necessary to agree upon a national strategy regarding submerged prehistory and landscapes, and to subsequently repeat the message of that strategy in dialogue with industry. Once we are clear about what we *want* to achieve (that is, archaeologically relevant information) and what we reasonably *can* achieve (in terms of research strategy and technology) within the context of development-driven projects, it will be much easier to turn negotiation into collaboration. In this context, making choices is essential. A national strategy can facilitate the dialogue with industry. Umbrella organisations of major stakeholder groups, such as the gravel and sand aggregates industry, will likely be more open to dialogue when archaeologists can provide clarity about what archaeology asks from industry, and that the archaeological sector is prepared to make choices. In the end, this may lead to actual collaborations, in which the engineering aspect is taken up by the industry itself.

5.6 Public outreach

As is clear from section 4.6, the past decade has witnessed an increased interest by the media in the subject of submerged prehistoric archaeology and landscapes, as well as direct involvement of non-professionals ('the public'). It is important to seek the continuation and reinforcement of activities that promote such interest. In fact, the achievements in the

Rotterdam-Maasvlakte 2 development are perceived in other nations as an example to follow.[141] The impact of the analysis and publication of archaeological stray finds in association with coordinated media coverage is also proving a very successful and valuable strategy. The Neanderthal skull fragment, isotope research on Mesolithic human remains, and the investigation of the oldest Dutch human and the oldest art fragment from the North Sea have demonstrated this (see appendix 1 and 2). Investigation of the drowning history of North Sea palaeolandscapes draws particular attention in relation to issues of climate change.

But certainly there is still much to be gain gained. As is the case with 'industry', 'the public' also comprises variable interests, with some members of the public strictly oriented towards archaeology and exiting finds and other members oriented towards broader topics, such as climate change and what this does to people. Clearly, climate change and socio-cultural dynamics are also topics that are intricately related and complementary. 'The public' also displays differences in age and level of knowledge. Private collectors who are actively searching for all sorts of items on beaches are dedicated non-professionals who have developed considerable knowledge. All of these subgroups of the general public should be approached and involved in different ways.[142]

The importance of education and engagement cannot be underestimated. After all, prehistoric archaeology is not just for archaeologists and scientists working in related disciplines. For non-professionals to feel that they are being taken seriously, is necessary for archaeologists to make them feel part of what archaeology wants to achieve. A good example of this is presented in the opening chapter of the recently published book *Wereldgeschiedenis van Nederland* (world history of the Netherlands),[143] which focuses on Neanderthals, and which places the find of the first Dutch Neanderthal (nicknamed Krijn) – and the importance of the unsurpassed archaeological treasure trove off our coast – centre stage. Active engagement nourishes a sense of shared responsibility, also within the communities of industry, heritage professionals, and scientists. It is therefore important to develop an outreach strategy, which outlines what we want to achieve, what message to bring across, whom we want to reach, how we want to reach them, and how to ensure continuity.[144]

5.7 Recommendations

The preceding sections have discussed various aspects that we consider to be of paramount importance for the next 10 years. As stated in the introduction to this chapter and the conclusions to chapters 3 and 4, the NSPRMF 2009 themes and topics remain topical and relevant. There is no pressing need to define a new set of themes and topics, and priorities have not yet been met to such an extent that no further attention is needed. At the same time, major steps have been taken with regard to some issues, notably data sharing, collaboration with private collectors, and public outreach. These steps are important, and the related efforts should be maintained. In this final section, we present some recommendations, which are meant to serve as guides for further discussion and for targeting actions in the near future. These recommendations are grouped under three headings: contents (the subject of investigation), process (strategies, methods, techniques), and stakeholders (regulations, risk assessment, communication).

Contents

A. Define the meaning of a 'good data point' to involve accurately georeferenced results of a consistently conducted analysis of geological, palaeoenvironmental, or archaeological observations/recordings of which the archaeological taphonomy and relevance is explicitly made clear.
B. Accept the possibility of loss of information due to methodological and technological limitations.
C. Do not restrict palaeolandscape mapping to land-surface mapping. Instead, include palaeoenvironmental analysis in order to provide data for contextual models, which are crucial for the archaeological understanding of prehistoric human-environment relationships.
D. Support efforts to register and contextualise ex situ (stray) finds to increase their information value for the assessment of offshore potential and support of decision making.

141 Sturt, Dix & Grant 2017, 434.
142 Satchell 2017.
143 Amkreutz & Dusseldorp 2018.
144 Because the archaeology of the drowned prehistoric landscape of the North Sea is a national and international topic per se, the Rijksmuseum van Oudheden has defined it as a focus area for research, collection, and public outreach. Among other things, this entails that the national museum of antiquities regularly organises contact-days for people involved in and interested in North Sea prehistoric archaeology, actively participates in research networks, and works at creating and expanding public interest. This has resulted in, among other outcomes, a private fund aimed at stimulating these activities, as well as plans for organising a (travelling) exhibition on North Sea prehistoric archaeology in 2020–2021, with venues to include the coastal provinces of the Netherlands. Additionally, due to its long-term involvement in North Sea archaeology (starting in the 1960s), the national museum of antiquities is actively working at obtaining a representative national collection of these finds. The current collection encompasses many dozens of finds dating to the Palaeolithic, Mesolithic, and Neolithic and includes lithic and organic finds of bone and antler, as well as human remains.

Process

A. Develop a clear strategy/work plan at the project level that covers the entire archaeological process (including assessment for archaeological potential) and that makes clear choices with respect to which questions are to be answered, and by means of which technology, for development areas where chances of follow-up are realistic.
B. Guarantee the reprocessing of data for the updating of spatial models in cases where a follow-up to ground-truth archaeological potential is unrealistic, and put in place funding for this reprocessing.
C. Involve experts at the front end of any project, in order to anticipate the many uncertainties underlying the modelling, surveying, and sampling of submerged prehistoric archaeology and landscapes; the interpretation of data; and the development of strategies for sampling, dating, and sub-bottom profiling.
D. Stimulate (and co-finance) methodological experimentation at all stages of project execution between initial desktop study and final reporting.
E. Consistently evaluate projects in relation to locations of comparable geographical and archaeological potential, in order to support methodological development; set up an expert group for this purpose.

Stakeholders

A. Ensure that geoarchaeological spatial models about the potential preservation of prehistoric remains and landscapes (i.e. potential for collecting good data points) express differences in spatial resolution (resulting from data availability) and are constantly updated using the latest insights. Make only the most up-to-date maps available to stakeholders, via a single national portal (e.g. the cultural heritage agency), and kept up-to-date on international portals (e.g. EMODnet).
B. Define (parameters of) 'archaeological potential' and define by which means potential can be assessed with regard to submerged prehistory and prehistoric landscapes.
C. Refrain from archaeological potential assessment of a development area where chances of any follow-up have already been deemed excluded or unrealistic. Instead, focus on geological mapping and palaeoenvironmental mapping for generic knowledge purposes, including archaeological purposes, such as the contextualisation of chance finds.
D. Accept loss of information due to restrictions imposed by technology, logistics, and safety, in addition to those imposed by time and money.
E. Work towards a principle of financial reallocation in relation to developments where a reasonable assessment of archaeological potential and possible follow-up for research is excluded, whereby the developer is required to put aside a sum of money equivalent to what the developer would have to have paid had there been follow-up research and allow this money to be used for offshore archaeological research elsewhere, so as to broaden the basis for future decision-making.
F. Emphasize the potential attractiveness of submerged archaeology in public outreach and in contributing to the societal responsibility and role of the industry involved.

Our final recommendation, which cross-cuts the three main headings above, is that an interdisciplinary and cross-national 'centre for North Sea prehistoric environments' be established that can serve as a platform for long-lasting scientific collaboration (sharing expertise and equipment, joint funding, training networks) and as a knowledge centre for research and management, and that can also support outreach initiatives of other organisations. The establishment of such a centre will require a lot of effort and an initial investment that will need to be supported by the state, but in our opinion the establishment of such a centre is feasible.[145]

[145] The European Research Council Synergy grants provide potential opportunities.

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Appendices

Appendix I
Results of press releases

This appendix provides a summary of the media coverage resulting from press releases concerning the find a a Neanderthal skull fragment (named 'Krijn'), and finds representing the earliest modern human and art known from the Dutch sector of the North Sea. The 'total media value' is the value of media items if they had to be bought, and provides an indication of impact value. Combined with all other received media coverage, this impact is enormous.

A Results of the press release KRIJN 'Neanderthal from the North Sea' (also see Appendix 2)

The divulgation of the first fossil bone of a Neanderthal from Dutch territory by Minister Plasterk in the national museum of antiquities (exhibition 'Neanderthaler uit de Noordzee') in 2009 received enormous attention from the media. Reporters were present in large numbers on behalf of e.g. NOS news (broadcast of 16:00, 20:00 and 22:00 pm), RTL4 news (broadcast of 16:00 pm), radio stations (e.g. Radio 1 news, ANP, BNR news radio), and virtually all national newspapers; in addition many science editors were represented. The press release of the national museum of antiquities was under strict embargo, and was supported by further press releases by the Max Planck Institute for Evolutionary Anthropology (Leipzig) and the National History Museum (London). Media attention of newspapers, radio, television and the internet reached well beyond the Dutch borders.

- 174 items in printed media (full page in the national newspapers NRC Handelsblad, De Volkskrant, Trouw, Algemeen Dagblad, Spits, Metro) with a total media value of € 298,715
- 13 items on radio and television
- 37 items online

B Results of the press release 'Earliest Human, Earliest Art'

The publication in Antiquity of a human parietal and decorated bone from the North Sea and dated to the Late Palaeolithic was associated with a press release by the national museum of antiquities. This also drew enormous media attention (newspapers, television, radio). Again, this media attention reached well beyond the Dutch borders.

- 73 items in printed media (full page in Archeologie Magazine, Dagblad van het Noorden, Leeuwarder Courant, Leidsch Dagblad., NRC Handelsblad) with a total media value of € 110,468
- 5 items on radio and television RTV
- 35 items online

Appendix II

Web items concerning the Neantherthal skull fragment 'Krijn'

Overview of web items retrieved from Meltwater News:

Neandertalerknochen aus der Nordsee gefischt

news.de – Mo, 27 Jul 2009 15:27
Anthropologie

Nordlicht

Welt Online – Mo, 27 Jul 2009 04:00
Neandertaler in der NordseeHamburg – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden. Wie das Magazin "Geo" in seiner August-Ausgabe berichtet, haben Leipziger Anthropologen bei der Untersuchung des Relikts festgestellt, dass es mindestens 40 000 Jahre alt ist – und damit der älteste je unter Wasser gefundene Menschenknochen.

Neandertaler-Knochen aus der Nordsee gefischt

Badische Zeitung – Mo, 27 Jul 2009 00:44
HAMBURG (dpa). Ein sensationelles Objekt hat ein niederländischer Muschelfischer mit seinem Fang eingeholt: ein mindestens 40 000 Jahre altes Stirnbein eines Neandertalers.

PALÄONTOLOGIE: Der Neandertaler aus der Nordsee

News4Press.com – So, 26 Jul 2009 15:04
Gruner+Jahr, GEO: Hamburg (ots) – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden. Wie das Magazin GEO in seiner August-Ausgabe berichtet, haben Leipziger Anthropologen um Jean-Jacques Hublin bei der Untersuchung .

PALÄONTOLOGIE: Der Neandertaler aus der Nordsee

Studenten.de – So, 26 Jul 2009 09:42
Hamburg (ots) – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden. Wie das Magazin GEO in seiner August-Ausgabe berichtet, haben Leipziger Anthropologen um Jean-Jacques Hublin bei der Untersuchung des Relikts festgestellt, dass es mindestens 40.

Knochen von Urmensch in Nordsee gefunden

SZON News – So, 26 Jul 2009 14:17
Bild: Neandertaler. Bild: Neandertaler. Ein sensationelles Objekt hat ein niederländischer Muschelfischer mit seinem Fang eingeholt: das Stirnbein eines Urmenschen.

Knochen von Neandertaler aus Nordsee gefischt

Kronen Zeitung – So, 26 Jul 2009 14:13
Einen sensationellen Fund hat ein niederländischer Muschelfischer mit seinem Fang gemacht: In seinem Netz fand sich nämlich das Stirnbein eines Urmenschen. Der mindestens 40.000 Jahre alte Teil des Neandertaler-Kopfes ist jedenfalls der älteste je unter Wasser gefundene Menschenknochen, wie Leipziger Anthropologen um Jean-Jacques Hublin (links im Bild) bei der Untersuchung des Relikts feststellten.

Muschelkutters – PALÄONTOLOGIE: Der Neandertaler aus der Nordsee

NewsXL – So, 26 Jul 2009 11:36
Hamburg (ots) – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden. Wie das Magazin GEO in seiner August-Ausgabe berichtet, haben Leipziger Anthropologen um Jean-Jacques Hublin bei der Untersuchung des Relikts festgestellt, dass es mindestens 40.

PALÄONTOLOGIE: Der Neandertaler aus der Nordsee....
FTOR – Finance-Community – So, 26 Jul 2009 11:03
Hamburg (ots) – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden. Wie das Magazin GEO in seiner August-Ausgabe berichtet, haben Leipziger Anthropologen um Jean-Jacques Hublin bei der Untersuchung des Relikts festgestellt, dass es mindestens 40.

PALC4ONTOLOGIE: Der Neandertaler aus der Nordse
Telelino – So, 26 Jul 2009 10:56
PALÄONTOLOGIE: Der Neandertaler aus der Nordsee Hamburg (ots) – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden.

> PALÄONTOLOGIE: Der Neandertaler aus der Nordsee
Cityvisits.de – So, 26 Jul 2009 10:35
Hamburg (ots) – Im Fang eines niederländischen Muschelkutters ist das Stirnbein eines Urmenschen entdeckt worden. Wie das Magazin GEO in seiner August-Ausgabe berichtet, haben Leipziger Anthropologen um Jean-Jacques Hublin bei der Untersuchung des Relikts festgestellt, dass es mindestens 40.

Mettmann: Kleine Gemeinschaft
RP Online – Mi, 22 Jul 2009 09:56
Ein Team mit dem Vorgeschichtler Ralf W. Schmitz hat nachgewiesen, dass die Population des Eiszeitmenschen weitaus geringer als früher angenommen war. Er wanderte vom Neandertal bis nach Kroatien.

The Mysterious Downfall of the Neandertals
Scientific American – Di, 21 Jul 2009 02:19
Paleoanthropologists know more about Neandertals than any other extinct human.

Inside This Issue: Neandertals and General Relativity
Scientific American – Mo, 20 Jul 2009 14:14
More from the Magazine August 2009 Issue Sustainable Developments Good News on Malaria Control [Extended version] Updates Whatever Happened to the Mars Rovers? In Brief News Scan Briefs: Killer Smile Buy the Digital Edition It was August 1856, three years before Charles Darwin would publish On the Origin of Species.

The Early Lateglacial Re-colonization of Britain: New Radiocarbon Evidence From Gough's Cave, Southwest England
Anthropology – Fr, 17 Jul 2009 04:19
Jump to Comments News from Gough's Cave in Cheddar Gorge, where Britain's earliest inhabitants following the Last Glacial Maximum are rumoured to have holed up; the paper is in press, (behind a paywall) via Quaternary Science Reviews.

Openingstoespraak van de Prins van Oranje tijdens de MARE conferentie 'People and the Sea' te Amsterdam, 9 juli 2009
Het Koninklijk Huis – Do, 09 Jul 2009 22:41
De toespraak is uitgesproken in het Engels. Ladies and gentlemen, Have you ever heard of Krijn? Krijn walked the earth around 50,000 years ago. A fragment of his skull was fished out of the North Sea, just off the coast of Zeeland, several years ago.

Trawler fisker Neandertal-kranie op af Nordsøen
Videnskab.dk – So, 28 Jun 2009 05:30
En del af et neandertal-kranie, fanget med trawl i Nordsøen, er det første fund af sin art.

Oudste muziekinstrument ter wereld gevonden
Elsevier – Do, 25 Jun 2009 19:15
Archeologen hebben met de vondst van een 35.000 jaar oude fluit in Zuid-Duitsland, het oudste door mensen gemaakte muziekinstrument ter wereld ontdekt.

Feestelijke oplevering Stiens centrum Oost, Leeuwarderadeel
Nieuws Bank – Mi, 24 Jun 2009 00:55
Gemeente Leeuwarderadeel Feestelijke oplevering Stiens centrum Oost 23-06-2009 16:26 Op vrijdag 26 juni a.s. zal de renovatie van de woningen en herininrichting van de straten in de wijk Stiens Centrum Oost feestelijk worden opgeleverd.

Digitale knipselkrant 23 juni 2009
Universiteit Leiden – Di, 23 Jun 2009 19:13
Voor deze digitale knipselkrant 'Universiteit Leiden in het nieuws' putten wij uit de database van LexisNexis. Door op de titel te klikken kunt u het bijbehorende artikel lezen.

Neanderthal Skull Fragment
Energy Digger – So, 21 Jun 2009 23:35
A Neanderthal skull fragment was retrieved from the North Sea. At the time Neanderthals occupied the area sea level was much lower than it is today.

First Dutch Neanderthal man found
Congoo – Sa, 20 Jun 2009 08:28
At last the Netherlands also has their Neanderthal man. Minister of Science Ronald Plasterk revealed the remains of the primeval Dutchman at the Leiden Museum of Antiquities.

Verband tussen vondstmeldingen 2007-2008 en Neanderthalervondst
Blik op Nieuws – Do, 18 Jun 2009 18:07
Middelburg – De vondst van het oude schedelfragment van een Neanderthaler houdt verband met eerdere vondstmeldingen in 1998 en 2007-2008 bij Stichting Cultureel Erfgoed Zeeland (SCEZ) in Middelburg. Regelmatig worden van de Noordzeebodem grote hoeveelheden fossiele beenderen van mammoeten en andere ijstijddieren opgediept en soms ook stenen werktuigen van Neanderthalers.

Neanderthal found in North Sea
Living in the O – Mi, 17 Jun 2009 22:36
A fantastic Neanderthal skull fragment has been found at the bottom of the North Sea. This is a really important find as it shows that Neanderthals were living around Britain around 60,000 years ago.

Neanderthal fossil found in North Sea
Breitbart.com: United Press International – Mi, 17 Jun 2009 04:48
LEIDEN, Netherlands, June 15 (UPI) -- Researchers in the Netherlands say they have confirmed a skull fragment dredged from the North Sea was that of a young adult male Neanderthal.

Neanderthal fossil found in North Sea
Times of the Internet – Di, 16 Jun 2009 05:12
LEIDEN, Netherlands, June 15 (UPI) -- Researchers in the Netherlands say they have confirmed a skull fragment dredged from the North Sea was that of a young adult male Neanderthal.

Ein Neandertaler aus der Nordsee
Berliner Morgenpost – Mi, 17 Jun 2009 04:00
Reste eines Neandertalers hat ein belgischer Sammler in Baggeraushub aus der Nordsee gefunden. Das Material war bei der Granatensuche gesiebt worden, dabei war das Schädelfragment entdeckt worden.

60,000-year-old Neanderthal skull fragment trawled up in North Sea
HNN – Mi, 17 Jun 2009 02:15
Source: Times (UK) (6-16-09) Part of an ancient human skull has been recovered from the North Sea in an area described as a drowned Stone Age hunting ground.

60,000-year-old Neanderthal skull fragment trawled up in North Sea
Times Online – Di, 16 Jun 2009 16:37
Part of an ancient human skull has been recovered from the North Sea in an area described as a drowned Stone Age hunting ground. The bone fragment is believed to belong to a late Neanderthal man and has been dated at around 60,000 years old.

Digitale knipselkrant 16 juni 2009
Universiteit Leiden – Di, 16 Jun 2009 22:01
Voor deze digitale knipselkrant 'Universiteit Leiden in het nieuws' putten wij uit de database van LexisNexis. Door op de titel te klikken kunt u het bijbehorende artikel lezen.

Twitter Self-picks for June 2009
Jafapete's Weblog – Di, 16 Jun 2009 20:34
Must watch RT @NASA: Dramatic changes our world has gone through in just 10 years, as captured by NASA spacecraft: http://tr.im/oA6q [Permatwit] Birth control by sterilizing male mosquitoes b4 mating renders female (mates once in life) eggs dud http://bit.

Fossiel van een neanderthaler ontdekt
Parool – Di, 16 Jun 2009 20:10
Kenmerkend is de dikke wenkbrauwboog van de neanderthaler, die van wetenschappers de naam Krijn heeft gekregen. Foto GPD LEIDEN – Voor het eerst is in Nederland een fossiel van een neanderthaler ontdekt.

Der Neandertaler aus der Nordsee
Die Zeit – Di, 16 Jun 2009 19:35
Vor Hollands Küste ging einem Fischer das Knochenstück einer Augenbraue ins Netz. Jetzt fanden Forscher heraus: Es stammt von einem Neandertaler und ist mehr als 40.

Volkskrant onderschrift: "Neanderthaler Minister Plasterk geeft maandag uitleg"
Retecool – Di, 16 Jun 2009 17:41
Linkdump Kabinet spreekt als uit één mond Heden te zien op http://www.volkskrant.

Neandertaler in der Nordsee
Epoc – Di, 16 Jun 2009 17:21
Während der letzten Eiszeit, als die Meeresspiegel so tief lagen, dass die Nordsee trocken lag, streiften nicht nur unsere Vorfahren durch die trockenen Tiefebenen – sondern auch unsere nächsten Verwandten, die Neandertaler.

De eerste Nederlandse Neanderthaler
Universiteit Leiden – Di, 16 Jun 2009 17:16
De vondst langs de Zeeuwse kust van een stukje Neanderthaler is de eerste in Nederland. Wil Roebroeks hoopt dat 'Krijn' de stap zal zijn tot onderzoek en bescherming van het Noordzeebodemarchief.

De eerste Nederlandse Neanderthaler

Nieuws Bank – Di, 16 Jun 2009 01:25
Universiteit Leiden * Nieuws De eerste Nederlandse Neanderthaler De vondst langs de Zeeuwse kust van een Neanderthaler is de eerste in Nederland. Wil Roebroeks hoopt dat `Krijn' de stap zal zijn tot onderzoek en bescherming van het Noordzeebodemarchief.

The Dutch Press Review 16 June 2009

SXM Island Time – Di, 16 Jun 2009 16:45
HOLLAND – First the headlines; * Amsterdam * archaeology * Arnhem * bilingual * Dutch history museum * Dutch Press Review * Eberhard van der Laan * epidemic * flu * Geert Wilders * Neanderthal.

60,000-Year-Old Neanderthal Skull Fragment Found in North Sea – Science News | Science & Technology | Technology News -

FOX News.com – Di, 16 Jun 2009 10:17
Part of an ancient human skull was recovered from the North Sea in an area described as a drowned Stone Age hunting ground. The bone fragment is believed to belong to a late Neanderthal man and has been dated at around 60,000 years old.

De eerste Zeeuw

Provinciale Zeeuwse Courant – Di, 16 Jun 2009 09:04
dinsdag 16 juni 2009 | 08:18 Tekstgrootte © Kennis&Kennis, 2009 De eerst bekende Neanderthaler in Nederland was een Zeeuw. Drie jaar geleden is een stukje van zijn schedel opgediept in het Middeldiep, zo'n vijftien kilometer uit de kust van Schouwen.

Een Neanderthaler: eindelijk

BN DeStem – Di, 16 Jun 2009 07:45
'Is dat nou alles, jongen? Dat verzuchtte de moeder van de Leidse archeoloog Wil Roebroeks, toen hij haar maanden geleden het botfragment liet zien. En inderdaad, het stukje schedel dat onderwijs-minister Ronald Plasterk gisteren in het Leidse Rijksmuseum van Oudheden Leiden met veel aplomb onthulde, oogt weinig indrukwekkend.

Fossiel Neanderthaler gevonden

Nijmegen Nieuws – Di, 16 Jun 2009 07:36
Voor het eerst is in Nederland een fossiel van een Neanderthaler gevonden, een stukje schedel van een jonge man. Het fragment, met de voor Neanderthalers zo kenmerkende forse wenkbrauwboog, is langs de Zeeuwse kust ontdekt en afkomstig van de Noordzeebodem.

Sea gives up Neanderthal fossil

HNN – Di, 16 Jun 2009 07:06
Source: BBC (6-15-09) Part of a Neanderthal man's skull has been dredged up from the North Sea, in the first confirmed find of its kind. Scientists in Leiden, in the Netherlands, have unveiled the specimen – a fragment from the front of a skull belonging to a young adult male.

Archeologen willen Noordzee-Instituut

Provinciale Zeeuwse Courant – Di, 16 Jun 2009 05:49
maandag 15 juni 2009 | 17:03 Tekstgrootte LEIDEN (ANP) – Nederland heeft ook zijn Neanderthaler. Het werd tijd, 153 jaar geleden werden de resten van een Duitse Neanderthaler ontdekt; de Belgen waren nog veel eerder (in 1829) maar hadden dat toen niet in de gaten.

Archeologen willen Noordzee-Instituut

Nieuwsblad Geldermalsen – Mo, 15 Jun 2009 17:00
LEIDEN (ANP) – Nederland heeft ook zijn Neanderthaler. Het werd tijd, 153 jaar geleden werden de resten van een Duitse Neanderthaler ontdekt; de Belgen waren nog veel eerder (in 1829) maar hadden dat toen niet in de gaten.

Met Krijn heeft Nederland nu ook een eigen neanderthaler

De Twentsche Courant Tubantia – Di, 16 Jun 2009 03:19
De schedel van Krijn, de eerste Nederlandse Neanderthaler. Foto: Marcel Antonisse LEIDEN – ; Nederland heeft ook zijn neanderthaler. Het werd tijd, want 153 jaar geleden werden de resten van een Duitse neanderthaler ontdekt.

First Neanderthal Fossil Dredged From North Sea

Anthropology – Di, 16 Jun 2009 03:11
Jump to Comments A fragment of a Neanderthal skull, dated to between 40,000 and 60,000 years has been recovered from the bottom of the North Sea, marking the first ever occasion such a find has been made, according to researchers from the Max Planck Institute for Evolutionary Anthropology in Leipzig, in collaboration with the University of Leiden.

De oudste Zeeuw

Trouw – Di, 16 Jun 2009 02:59
Na diverse vuistbijlen en andere gereedschappen is daar eindelijk het echte tastbare bewijs: een origineel stukje Nederlandse Neanderthaler.

Troythulu's Nu'z 1.15.6

Sociolingo's Africa – Blog – Di, 16 Jun 2009 01:29
[1] Sea gives up Neanderthal fossil; Part of a Neanderthal man's skull has been dredged up from the North Sea, in the first confirmed find of its kind... [2] Herschel telescope opens 'eyes'; Europe's new billion euro Herschel space observatory, launched in may, has achieved a critical milestone... [3] Uncool Monkey News! A chimpanzee apocalypse in Tanzania; Tanzania's chimpanzee population has plummeted by more than 90%, from 10,000 a few years ago, to just 700 today, according to a report from the Tanzania

Dutch Neanderthal Fossil unveiled by Minister

Idredge – Di, 16 Jun 2009 01:26
(PalArch) Spectacular discovery of first-ever Dutch Neanderthal Fossil skull fragment unveiled by Minister Plasterk in National Museum of Antiquities For the first time ever, a fossil of a Neanderthal has been discovered in the Netherlands.

De lessen van onze Neanderthaler

Elsevier – Mo, 15 Jun 2009 22:33
1. Het journaal deugt niet U hebt het allemaal gelezen. Er is voor het eerst een botje van een Neanderthaler gevonden die tienduizenden jaren geleden leefde in het grondgebied van wat we nu Nederland noemen.

Eerste Nederlandse neanderthaler had tumor

DePers – Mo, 15 Jun 2009 22:32
Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het meer dan 40.000 jaar oude stukje schedel van een jonge man is gevonden langs de Zeeuwse kust en is afkomstig van de Noordzeebodem.

Eerste Nederlandse Neanderthaler had een tumor

Het Nieuwsblad – Mo, 15 Jun 2009 22:25

LEIDEN – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het meer dan 40.000 jaar oude stukje schedel van een jonge man is gevonden langs de Zeeuwse kust en is afkomstig van de Noordzeebodem.

Opzienbarende vondst eerste Nederlandse Neanderthaler

Blik op Nieuws – Mo, 15 Jun 2009 22:02

Leiden – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het meer dan 40.000 jaar oude schedelfragment met kenmerkende dikke Neanderthalerwenkbrauwboog is gevonden langs de Zeeuwse kust en is afkomstig van de Noordzeebodem.

Coffee Break: June 15

Science Fair – Mo, 15 Jun 2009 21:05

NASA fixing leak on shuttle fuel tank ... Amazing facts about the moon ... The science behind sneezes and coughs ... Bacterium called “resurrection bug” revived .

Researchers Find Partial Neanderthal Fossil In North Sea

redOrbit – Mo, 15 Jun 2009 20:41

Scientists in the Netherlands have found part of a Neanderthal man’s skull that has been dredged up from the North Sea, BBC News reported. The specimen is a fragment from the front of a skull belonging to a young adult male and experts say it is the first confirmed find of its kind.

Leidse archeologen onthullen eerste Nederlandse Neanderthaler

Leidsch Dagblad – Mo, 15 Jun 2009 19:14

leiden – Is dat nou alles, jongen? Dat verzuchtte de moeder van de Leidse archeoloog Wil Roebroeks, toen hij haar maanden geleden het botfragment liet zien.

‘Neanderthaler uit de Noordzee’ te zien in RMO

Sleutelstad – Mo, 15 Jun 2009 19:12

LEIDEN – 15 juni 2009 – Vanmiddag heeft minister Plasterk het unieke schedelfragment van de eerste Nederlandse Neanderthaler onthuld in het Leidse Rijks Museum van Oudheden. Het meer dan 40.000 jaar oude schedelfragment, met kenmerkende dikke Neanderthaler-wenkbrauwboog, is gevonden langs de Zeeuwse kust en afkomstig van de Noordzeebodem.

SEA GIVES UP NEANDERTHAL FOSSIL

Nigerian Best Forum Blog – Mo, 15 Jun 2009 19:07

By Paul Rincon Science reporter, BBC News The fragment of skull belonged to a young adult male Part of a Neanderthal man’s skull has been dredged up from the North Sea, in the first confirmed find of its kind.

Eerste Neanderthalerfossiel in Nederland

Rtlz – Mo, 15 Jun 2009 18:55

Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het gaat om een stukje schedel van meer dan 40.000 jaar oud.

Neanderthal Skull Fragment Dredged from North Sea

Softpedia – Mo, 15 Jun 2009 18:06

The species was our close “evolutionary cousin”

Eerste Nederlandse Neanderthaler gevonden
NOS – Mo, 15 Jun 2009 17:53
Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het is een schedelfragment van meer dan 40.000 jaar oud, dat werd gevonden in de Noordzee.

Nederland heeft eigen Neanderthaler
De Gelderlander – Mo, 15 Jun 2009 17:03
Tekstgrootte Minister Plasterk geeft maandag in Leiden uitleg aan de hand van een gereproduceerde schedel van een Neanderhaler over het gevonden botfragment.

Eerste Neanderthaler fossiel gepresenteerd in Leiden
Radio TV West – Delft Westland – Mo, 15 Jun 2009 16:54
Tell a friend LEIDEN – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het meer dan 40.000 jaar oude stukje schedel is gevonden op de bodem van de Noordzee.

Eerste Neanderthaler fossiel gepresenteerd in Leiden
Radio TV West – Den Haag Haaglanden Zoetermeer – Mo, 15 Jun 2009 16:54
Tell a friend LEIDEN – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het meer dan 40.000 jaar oude stukje schedel is gevonden op de bodem van de Noordzee.

Resten Neanderthaler in Noordzee
AD.nl – Mo, 15 Jun 2009 16:49
ROTTERDAM – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het is een stukje van een schedel van meer dan 40.000 jaar oud.

Eerste Neanderthaler had een tumor
AD.nl – Mo, 15 Jun 2009 16:49
LEIDEN – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het meer dan 40.000 jaar oude stukje schedel van een jonge man is gevonden langs de Zeeuwse kust en is afkomstig van de Noordzeebodem.

Eerste 'Nederlandse' Neanderthaler gevonden
FOK Frontpage – Mo, 15 Jun 2009 16:10
Voor het eerst is in Nederland een fossiel van een Neanderthaler gevonden. Het gaat om een stukje schedel van de uitgestorven mensachtige. Het fragment is op de storthoop van een schelpen-verwerkend bedrijf in Zeeland ontdekt en is het eerste menselijke fossiel ter wereld dat uit zee afkomstig is.

Botfragment Nederlandse Neanderthaler gevonden
Trouw – Mo, 15 Jun 2009 15:53
(Novum) – Voor het eerst is in Nederland een fossiel van een Neanderthaler ontdekt. Het veertig-duizend jaar oude schedelfragment is enkele jaren geleden gevonden langs de Zeeuwse kust in de Noordzee. Daar worden al decennialang botfragmenten boven water gehaald, maar een Belgische amateurpaleontoloog die de vangst van een schelpenzuiger uitpluisde, stuitte op het bijzondere stukje bot.

Resten Neandertaler gevonden in Zeeland
Provinciale Zeeuwse Courant – Mo, 15 Jun 2009 15:22
maandag 15 juni 2009 | 14:02 | Laatst bijgewerkt op: maandag 15 juni 2009 | 14:31
Een deel van de schedel van een Neandertaler met de kenmerkende wenkbrauwbogen.

Sea gives up Neanderthal fossil [dredged up from the North Sea]

Free Republic – Mo, 15 Jun 2009 15:19

Scientists in Leiden, in the Netherlands, have unveiled the specimen – a fragment from the front of a skull belonging to a young adult male. Analysis of chemical “isotopes” in the 30,000-60,000-year-old fossil suggest a carnivorous diet, matching results from other Neanderthal specimens.

Eerste ‘Nederlandse’ Neanderthaler gevonden

De Volkskrant – Mo, 15 Jun 2009 15:07

14:00, bijgewerkt op 15 juni 2009 14:11 LEIDEN – Voor het eerst is in Nederland een fossiel van een Neanderthaler gevonden. Het gaat om een stukje schedel van de uitgestorven mensachtige.

Botje Nederlandse Neanderthaler gevonden

Elsevier – Mo, 15 Jun 2009 14:00

Eindelijk heeft ook Nederland zijn neanderthaler. Vanmiddag heeft minister Ronald Plasterk (PvdA) van Wetenschap in het Rijksmuseum van Oudheden in Leiden het restant van de ‘oer-Nederlander’ onthuld.

Onthulling van bijzondere archeologische vondst door minister Plasterk

Nieuws Bank – Do, 11 Jun 2009 17:16

U hebt een pagina opgevraagd uit het Nieuwsbank persberichtenarchief en u bent geen abonnee. Daarom vragen wij u nu een kleine bijdrage voor het onderhoud van onze persberichtenverzameling.

It is general knowledge that the southern North Sea harbours a vast array of submerged prehistoric archaeological and environmental remains. In 2009, the North Sea Prehistory Research and Management Framework (NSPRMF) set out a broad set of research and management themes, topics and priorities which were deemed relevant regarding the prehistoric cultural heritage of the southern North Sea. Now, in 2019, we address the question: Where do we stand after a decade of work? In the past ten years, a lot of work has been done and progress has been made; however, we are still far from meeting all of the priorities defined. While the themes and topics of the NSPRMF 2009 remain relevant today, based on the experiences over the years, they have been revised and updated for this NSPRMF2019.

This scientific report is intended for archaeologists and other professionals, as well as amateur enthusiasts, interested and involved in the research and heritage management of the prehistoric archaeological and landscape remains hidden below the southern North Sea.

The Cultural Heritage Agency of the Netherlands provides knowledge and advice to give the future a past.