1. INTRODUCTION

The need for a sound scientific and transparent evidence base to inform coastal decision-making has never been so vital. Issues associated with increasing development pressures along much of the world's coast, coupled with the likely exacerbation of coastal erosion and flooding from potential climate change, are compounded by the widely observed science-policy disconnect pervading coastal decision-making ([1]; [2];[3];[4];[5]). Science needs to be placed centre stage in efforts to manage the complex interactions between human activities and coastal processes, in order to secure a sustainable future for vulnerable coastal communities ([6]; [1]; [2]). However, there is little research helping us understand the communication and use of science in coastal management [7].

This paper investigates the role of science within coastal risk management in the UK. In this context, science refers to the natural coastal change information needed to understand and explain changes occurring on the coast relevant to coastal risk management. The paper provides an evaluation of the scientific basis of Shoreline Management Plans (SMPs). These plans have been central to the government's strategic approach to sustainable coastal risk management in England and Wales over the last couple of decades. As elements of their approach have been suggested as a model for elsewhere in Europe (through the EUROSION project, for example [8]) it is timely to review the science needs and use within these plans.

The paper commences with an overview of development and key characteristics of coastal risk management in England and Wales, focusing on the policy context for the initial development and early evolution of SMPs. After outlining the methodology adopted for a content analysis of a selection of plans, key findings are presented. Finally, the paper explores the study's implications for coastal management both in the UK and elsewhere, focusing on the use of science within the evidence base for coastal decision-making.

2. CONTEXT

2.1 Coastal hazards and the context for shoreline management planning

Much of the UK's coastline is vulnerable to coastal erosion and flooding [9], particularly low-lying expansive bays and estuaries where much of the population resides. A combination of high levels of development and vulnerability to storm surges around the Irish and North Sea coasts ([10], [11]) along with sea level rise make the problem particularly acute. Major flood events at the coast, for example, the winter storms in 2013/14 in the UK have placed a high media and political spotlight on the responses being taken to manage coastal hazards. Despite increased adoption of 'soft' engineering solutions ([12], [9], [13], [14]), most of the extensive stretches of urbanised coast are fronted by traditional 'hard' engineering structures ([15], [16], [12], [17]).

Over the last few decades there has been a gradual recognition that the location and design of many 'hard' engineering structures, have been based on short-term, reactive and ad hoc decision-making and a limited understanding of physical coastal processes at local and regional scales [18]. Carter et al. (1999) [19], Tunstall et al. (2004) [10] and Evans (1992) [13] have suggested that limited geomorphological understanding has contributed to the parochial and inappropriate basis of much engineering activity along the coast. Over twenty years ago Clayton and O'Riordan (1995, pg. 159-

160; [20]) also noted that structures, "…rarely last more than 40 years, and some fail quite soon after construction if the coastal geomorphology is not fully understood". Despite such concerns, hard defences have frequently created a false sense of security amongst 'protected' communities [21]. This has often resulted in further development in hazardous areas, following the 'development-defend cycle,' as described by Carter et al. (1999: [19]), and exacerbating coastal risk to communities. This is now compounded by the fact that many of the structures which were constructed over half a century ago are now reaching the end of their design life and are costly to maintain.

In response to these issues, there has been a gradual shift from a parochial, scheme-by-scheme approach to coastal defence in England and Wales to one based on a wider, regional assessment of coastal erosion and flood risk ([22], [23]). The definition of discrete littoral, sediment cells within which the movement of sediment is relatively self-contained (Figure 1), was central to this this new approach ([24], [25], [26]). The cost imperative also forced consideration of a broader range of coastal defence options, as well as the need to take a risk-based approach to shoreline management. Encapsulating these elements, shoreline management planning has emerged to provide a strategic, regional context for local coastal strategies and coastal engineering schemes. Reflecting sediment cell-based management units and designed to be informed by the best available natural coastal change scientific evidence, shoreline management plans (SMPs) have been the first attempt within Europe to attempt to provide planning based on large-scale assessment of shoreline management processes over long-term timeframes.

Figure 1

1.2 Shoreline management plans: the policy and governance context

In the context of a regional assessment of coastal risks, SMPs have assigned generic policy options for small stretches of shoreline along the entire coast, based on coastal physical and human characteristics. These policy options are intended to inform the development of more detailed coastal defence strategies and local coastal defence schemes, including both hard and soft engineering projects. The first generation of plans, developed between 1996 and 1999, and the subsequent and current, second generation (2007 -) plans allocated one of four possible policy options (Table 1) for each and every discrete management unit along the plan's coastline, Shoreline Divisions (SDs). Whilst these plans are unlike land use plans in that they are non-statutory documents, they are instrumental in determining the likely shape and location of the coastline for the next century, albeit their implementation is dependent on subsequent investment. Although the first generation of plans (SMP1) provided policy options for a fifty year period, the current generation of SMPs (SMP2), more ambitiously, has defined options for each of three designated planning epochs, up to 2025, 2055 and 2100, following government guidance. This longer time horizon was considered necessary in the context of the considerable time frames associated with coastal and particularly climate, change.

Table 1

The development of this risk-based regional planning approach has been informed and supported by a succession of government policy and guidance [29], from the landmark 1993 'Strategy for Flood and Coastal Defence for England and Wales' to more recent national strategies for England and Wales ([30]

and [31]). However, the detailed overseeing of plan production has been devolved to regional Coastal Groups [32]. These voluntary collaborative partnerships of local government and other bodies have a spatial coverage that coarsely mirrors that of the major coastal cells around the coast of England and Wales. However, with limited capacity to develop the plans themselves, particularly given the scale and scope of the documents, most Groups chose to commission external specialist engineering consultancies to produce the plans on their behalf. The plan's development was overseen and delivered via a Client-Consultant Group. The outsourcing of coastal engineering-related activity by coastal Local Authorities and other public bodies, resulting from limited in-house skills, expertise and time, has become common practice in the UK. Indeed in many coastal Local Authorities coastal management, including shoreline management planning and coastal engineering is not a core service. Given the non-statutory nature of the plans, the onus remains on the Operating Authorities within the Coastal Group, those bodies with statutory powers to undertake flood defence or coast protection activities, including Local Authorities, to adopt and implement the plans.

No less than three sets of government guidance (1995 [27] 2001 [33] ,2006 [34] have been issued to help inform the development of these plans, particularly to encourage science-based and inclusive approaches to plan preparation. Within the initial (1995) guidance, the 'Blue Book', it was recommended that a single central repository of data should guide subsequent data analysis and plan development. A checklist was provided to ensure key aspects (including coastal processes, coastal defences, land use and human and built environment and the natural environment) were included. However, given the scale of the plans, the mere collation of existing data was an unprecedented and huge task which resulted in the generation of very little new / primary data *per se*. Although subsequent guidance [33] attempted to steer planners to "utilise an improved understanding of both coastal processes and coastal morphology information…in order to identify sustainable shoreline management policies" ([33], pg. 36) further guidance six years later was deemed necessary in the light of the perceived weak evidence base of many of the plans. This more prescriptive and detailed guidance focused on scientific evidence requirements, data collation and analysis as well as on stakeholder engagement in plan preparation [34]. This last aspect was a particular area of concern due to a lack of public participation within SMP development.

3. METHODS

A documentary-based evaluation of SMPs was undertaken to explore the role of science within coastal risk management decision-making. In particular, this research sought to understand the scientific foundations of SMP development, focussing upon the application of scientific knowledge and understanding in the selection of specific management policies for individual stretches of coast.

The evaluation analysed a range of plans from across England and Wales for the period 1996 to 2007. The following criteria informed the selection:

- The generation of SMP and specific government guidance informing plan preparation. Representative plans from each of the following were sought:
    - 'First generation' SMP1 plans, developed under the 1995 guidance (1996-1999);
    - SMP2 pilots (2006) following the 2001 guidance; and
    - SMP2s prepared using the 2006 guidance (2007 -).

- The geographical context of the plan: including plans within different regions (England, Wales, cross-border areas, East coast, West coast and North West coast) as well as plans covering developed, open rural stretches of coast and estuaries;
- The types of consultancy used to prepare the plan: including local, regional and national consultants
- The full range of generic policy options: Do Nothing, Hold The Line, Natural Defence Management, Managed Retreat and No Active Intervention.

To retain plan anonymity, each plan has been allocated an alphabetic prefix (a – xxx) and individual Shoreline Divisions (SDs) have been given a numeric code (i – iv). Given the the scale of the review, only one example of each type of policy option was assessed for each SMP. In practice, given the preference to include plans for different geographical areas, not all policy options were present in all plans. As a result of this selection process, twenty SDs were available for analysis from seven SMPs (Table 2; Figure 1).

Table 2

A systematic two-stage process using standardised proforma was required to ensure comparability of plans. This Evaluation Framework process, shown in Figure 2, included assessments for:

1. **Each whole plan – a SMP Preliminary Assessment** – A qualitative rapid analysis of the overall SMP document.
2. **Each SD – a Qualitative Assessment and a Quantitative Grading** - Following an initial, qualitative assessment, each SD was allocated two initial grades, one for its scientific basis and the other for its decision-making transparency. These were then combined to produce an overall grade for each SD (Figure 2 and Table 3). Such an approach is not dissimilar to that used by Tang et al. (2013:) [35] in the assessment of the scientific underpinning of climate change strategies and by others (such as [36]) evaluating the evidence base of Environmental Impact Assessment processes.

Figure 2

Table 3

SMP PRELIMINARY ASSESSMENT

The SMP Preliminary Assessment gathered contextual information, providing an overview of each plan which subsequently enabled a classification of the SMPs for further analysis. This assessment identified the lead Local Authority, the Coastal Group and the commissioned consultants for each plan as well as the version of government guidance under which the plan was prepared.

SHORELINE DIVISION (SD) QUALITATIVE ASSESSMENT

This second stage used a proforma to gather basic information related to the characteristics of each SD (Part A: the general SD description) as well as details related to the screening and policy appraisal process used by the consultants (Part B: the Intervention Appraisal) to inform the determination of the final policy (Part C: the 'preferred' policy option). Information on the type of shoreline, coastal processes, coastal defence structures, land ownership and statutory nature conservation designations

were collated for each SD as well as details of future studies and monitoring programmes relevant to the scientific underpinning of SMP policy. When reviewing information, the following aspects were considered:

- Presentation (level of detail, conciseness, clarity and logic as well as integration between topics);
- Organisation (tabular, bullet points, paragraphs of text, well structured);
- Use of supporting references; and
- Indication of any assumptions, limitations and uncertainties associated with the evidence base.

THE SD GRADING PROCESS

Following and partially informed by the qualitative assessment, the final stage involved a semi-quantitative evaluation of both the '*scientific basis and underpinning'* and the '*decision-making and transparency*' associated with each SD. Table 4 summarises the four criteria and associated scoring system used to evaluate '*scientific basis and underpinning*.' The scores were then weighted according to the relative importance of the criteria, informed from discussions with relevant experts and practitioners. Within these it was agreed that '*data content and coverage'* was most important and, hence, this was given a value of 50%. Table 5 illustrates the scoring and subsequent grading system (A – C), along with a worked example. Table 6 presents the rationale for the 'decision-making and transparency' grading (1 – 3) which focused on matters relating to the transparency and justification of the decision-making pathway. The combination of this grading along with that determined for the 'scientific basis and understanding' provided the final overall score for each SD. As such, 'A.1' is the best possible combination and C.3 the worst.

Table 4

Table 5

Table 6

4. RESULTS

4.1 Results of the SD Qualitative Assessment

Our initial assessment revealed that the general descriptive summary of each SD (Part A) generally provided a very brief, concise overview with frequent references to many aspects relevant to coastal risk management. This included details of statutory planning policies, nature conservation designations and existing coastal defence provision. Whilst the broad coverage of topics was commendable, the presentation and level of detail was variable and often limited. There was generally considerable information on the location, type and length of defence within first generation (SMP1) plans although little on the operational responsibility, condition or residual life of the defences, despite this having been explicitly requested under SMP1 guidance. SMPs, in contrast did not provide information on existing coastal defences although they did include maps highlighting areas at risk from coastal flooding (Environment Agency (EA) flood zone maps) as well as maps showing the predicted shoreline position for 2025, 2055 and 2105. However, rarely did the overview show either generation of plans acknowledging the gaps, uncertainties and assumptions associated with the evidence base. Second generation SMP2s generally provided more detail on nature

conservation designations and often included GIS-derived maps precisely indicating the locations of designations. In contrast, SMP1s generally only supplied basic information and frequently omitted specific site details, including reasons for designations, details of site managers or implications of coastal defence provision on such features.

Part B, the intervention appraisal, generally included information on physical characteristics and frequently a commentary on assets at risk as well as a brief overview of the shoreline and its evolution. However, the latter was often general to the sediment sub-cell rather than being specific to the SD. In general SMP1 SDs contained greater information than in the SMP2s. Descriptions of the physical character of the SD, including its geomorphology and coastal processes were frequently outlined, but mainly in short bullet-point statements. On rare occasions there was found to be more detailed information, for example, "This section of shoreline has been historically stable/modestly accreting over the past 150 years" (Plan diii). However, in such cases there was often no scientific citation or cross-referencing to specific sources of this information either from the data collation stages of the SMP process or from within any supplementary SMP reports or appendices. Very few SD acknowledged data gaps and uncertainties in relation to erosion rates and the residual life of existing defence schemes.

The detail within the economic assessment of Part B varied between SMP1s and SMP2s. Whilst SMP1s divided assets at risk into those with tangible and intangible benefits, few SDs included preliminary estimates of the value of assets at risk. Only in one case was there a clear statement regarding uncertainty related to economic assessment, Plan eii. This suggested that costings were 'unknown' and 'would require consideration of economic value of environmental resource." No cross-referencing was provided to support any economic assessments in SMP1s. In contrast, the economic assessments in SMP2s contained more detail and some indication as to how the figures had been calculated.

In presenting the 'preferred' policy in Part C of the SDs, plans provided a strategic assessment of policy options which, in most SDs (85%), included reference to the existing coastal defence policy within a supporting table. The screening of policy options was commonly supported by a description of associated issues and implications for policy choices. However, screening of policy options was generally more in-depth in the SMP1s. In SMP2s the supporting text for preferred policy options merely justified the policy direction within the context of the wider SMP. The screening of policy options was frequently presented within a matrix, particularly in the SMP1s. These used various criteria, including: effects on coastal processes, opportunities for environmental enhancement and sustainability as well as concordance with plan objectives. However, the detail for each criterion varied as did the reasoning and justification of the preferred policy in the supporting text. This ranged from a few words of explanation through to detailed costings of preferred policies and action plans outlining proposed actions. Although this screening of policy options generally provided the most transparent consideration of issues within the SMPs at the SD level, there was still a general lack of cross-referencing and little indication of uncertainties and gaps.

4.2 SD Grading Results

Scientific Basis and Underpinning

Based on the completion of the SD Grading Proforma (Table 4), Figure 3 summarises the overall performance of the SDs in relation to all four assessment criteria related to '*scientific basis and underpinning.*' Figure 4 displays the scores allocated to each specific SD based for this first stage of the SD grading process. Within this figure similar alphabetic prefixes indicate SDs within the same SMP. In summary, no SDs scored full marks across all the criteria and there was considerable variety both between and within SMPs, as detailed below.

Figure 3

Figure 4

With respect to *'data content and coverage'* most plans and SDs (65%) were supported by variable levels of data. The most extensive data and specific information were associated with four SDs in two SMPs produced by the same consultancy, using the early 1996 national guidance. Conversely, the lowest scores (0) were obtained for two SDs within a single, different SMP, prepared under the 2006 guidance.

With reference to '*presentation and synthesis*', there was considerable variation between the scores allocated to SDs from different plans (Figure 3) and between SMPs produced by different consultants. However, the same two plans which scored highly under '*data content and coverage'* received the highest scores for this criterion, indicating well organised, structured and concise presentation of data. In the remaining plans, most of the SDs adopted mixed presentation methods including lists, bullet points and short descriptive text. Within these few included more than a minimal synthesis or integration of information, as noted above. 35% of the SDs, from three SMPs, each produced by different consultants, scored very low on this aspect. These had large paragraphs of texts in some sections, with others including lists and bullet points, but with no supporting or analysis. None of the SDs which involved a SMP policy change in the second and third plan epochs received scores higher than 1 on this.

Whilst the overall trends for the scores for '*traceability*' per SD were not dissimilar to that for '*presentation and synthesis,*' the scores were considerably lower with only two SDs within a single SMP gaining the top score of 2, indicating suitably, detailed cross-referencing. Given that there was no cross-referencing in nine of the SDs (45%) these received a score of zero. The spread of low scores across most of the SMPs, and consequently across a range of consultants and guidance, was both surprising and disappointing.

'Scrutiny and quality assurance', the lowest scoring theme, gained no scores of 2, indicating no explicit reference to areas of uncertainty and limitations. Half of the SDs had no referencing or scientific citations and made no attempt to indicate gaps and uncertainties associated with the data. This included three out of the four SDs where there was to be a change in SMP policy (including to managed realignment). Whilst the other half of the SDs did indicate some data gaps and uncertainties and some even noted future studies and monitoring, there was no specific information on such aspects. Instead, there were general comments about uncertainties, most often associated with sea level rise (7 SDs) and increased storminess (8 SDs). Whilst later plans might have been expected to have included such aspects, there appeared to be no relationship between the amount of detail on climate change-related

aspects and the date of plan production. Only within a small minority of plans was uncertainty related to the residual life of defences mentioned or the evolution of natural coastal processes referred to. The SDs where uncertainty was briefly mentioned were generally those receiving consistently higher scores for other criteria.

Existing monitoring schemes were only referred to within seven of the SDs, with no reference to these in two of the 2006 plans. Such references were generally to beach profiling, although in two SDs saltmarsh morphological changes and bird population monitoring were also briefly mentioned. Ten SDs mentioned future monitoring. However, the inclusion of monitoring appeared generally not to be driven by a change in policy *per se*. Future monitoring was proposed for a wide range of parameters including beach profiling, wider sediment movements, ecological aspects and inshore wave conditions.

Decision-Making Transparency and Justification of Schemes

Figure 5 shows the scores allocated to the SDs in the context of the *transparency and justification* of SD decisions. Only three SDs (15%) from a single SMP produced under early national guidance were regarded as having both a transparent and well-justified decision-making pathway. In contrast, eight SDs (40%) from two SMPs, produced by two separate consultancies under the 2006 guidance, were considered as having decision-making pathways that were neither transparent nor fully justified. This included most of the SDs where a change in policy was proposed from the first to second epoch.

Figure 5

4.3 SD Grading Combined Results

Figure 6 shows the combined overall grading scores, summarising both the '*scientific basis underpinning*' score and the '*transparency and justification of decision-making*' score for each SD. As can be seen from this, the combined grading reflects a mixed performance. Only eight of the twenty SDs within three of the SMPs, produced by a couple of consultancies, achieved an 'excellent' grade for either category and no SDs at all received an 'excellent' score for both. Where 'excellent' scores were achieved for one criterion a variable score was obtained for the other criterion in all cases. Conversely, nine SDs from five SMPs and produced by the same consultancy scored poorly on one or other of the grades with three SDs from two SMPs scored poorly across both criteria. The latter include one SD where there is to be a change in policy from HTL to MR.

Figure 6

With only a very few exceptions, there appears to be a general relationship between the consultancy producing the SMP and the final combined score. As expected higher scores were generally obtained for SMP2s produced under later guidance although moderately good scores for both elements were achieved for many SDs prepared under the 1995 guidance.

5. Discussion

The evaluation of the scientific basis and transparency of the policy options revealed a relatively weak natural coastal change scientific underpinning for the most of shoreline management plans with 60%

of the SDs failing to achieve an 'excellent' grade on either grade score using our novel quantitative scoring system. Whilst the weak scientific underpinning of the SMP1 plans has been relatively well documented (see, for example: [37];[38]), and indeed was a key reason for the revision of the plans, as noted above, the limited improvement for the SMP2s was somewhat surprising. This was particularly disappointing given Government efforts to improve the knowledge base through various wide-ranging national projects including FutureCoast [39] and the Foresight Future Flooding Assessment [40] in the intervening period between SMP1 completion and SMP2 preparation [38]. Indeed, Nicolls et al. (2013) [38] suggested that this broader swathe of coastal science should provide an adequate framework for coastal decision-making well into the 21st century. However, the systematic evaluation applied here suggests poorly evidenced data input for some SMP2s including poor referencing and limited acknowledgement of key scientific uncertainties for most policy options at the SD level. Why should this be so?

Consideration of the SMP production process may provide clues as to why there was no apparent step change improvement in the scientific underpinning and transparency of the SMPs. Whilst the short-time frame has been cited elsewhere as a potential reason for the weak evidence base of the SMP1 programme, the continued dependence on out-sourcing shoreline management planning activities to external engineering-based consultancies, with both finance and time constraints, may be a contributory factor. With each SMP production process being overseen by a SMP Client-Consultant Group, there would also have been opportunities for scoping and reviewing the plan's contents at each stage of its development. Building on an assumed client confidence in the consultancy, following a compulsory tendering process, discussions throughout the plan production process could have led to further trust being built up between the clients (Coastal Groups) and their consultancies. Indeed, the potential growth of 'social robust knowledge' through such a discussion process is likely to have resulted in final policy options, acceptable to the client [41]. The nature and details of discussions relating to individual SDs are clearly well beyond what could be expected to be reported in the already voluminous sets of SMP documents. Whilst it is not suggested that this would have led to 'anything goes,' within the SMP2s it may have led to corners being cut in the 'documenting' of the science, including cross-referencing between SMP1 and SMP2 documentation. Given that SMP1 documents are rarely online or easily available, this may also have been an enabling factor.

In the context of the limited documented evidence found in this study and the nature of the client-consultancy relationship outlined above, there are further concerns. Cooper et al. (2002) [42] noted the reluctance to move from the 'status quo' (Hold the Line) to other policy options in SMP1s. Whilst the need to maintain protection for extensive coastal conurbations and associated assets could partly explain this, Nicholls et al. (2013) [38] have suggested that this trend also arose as a consequence of the engineering-focus of the consultancies (with implied vested interests in the HTL option). Although there were changes in policy in SMP2, the continued dominance of the 'status quo' for many stretches of coast is noticeable – thus keeping the 'development-defend cycle' forever in motion. In such cases, it may be that the 'community' including the Coastal Group, has grown 'accustomed' to a particular 'defence' solution, and therefore has not needed so much 'proof' for the continuation of this policy option. This in turn may have led to limited evidence framing a policy-driven option rather than extensive evidence framing a science-based policy. There have also been suggestions by Cooper et al. (2002) [42] that 'external' discussions have on occasions lead to the overturning of policy options against the original advice and evidence provided by the consultancy. In such cases it might be

assumed that there would be a 'light' touch to the scientific underpinning in SMP or perhaps even a tailoring of the evidence to create policy-based evidence. Without knowing the details of the specific process of decision-making for each and every SD in this study, it is impossible to gauge whether or not this is relevant to our findings.

There is little doubt that SMPs have provided a useful regional strategic overview of natural processes and, as such a useful context for local decision-making, including coastal scheme development. Perhaps it is just too much to expect that these plans should have been able to downscale from the regional scale to the very local scale and provide a distinct evidence trail for each and every each section and kilometre of coast, particularly given the nature and complexities of coastal systems? The lists of supporting documents and evidence in the SMPs already can amount to many pages of references, as noted above. However, the prescribed plan process and format, from a government with a 'modernising' agenda with evidence-based policy as one of its central tenets, has raised expectations that every decision, including those at local levels, should be clearly evidenced whilst also framing problems in terms of short-term delivery [43]. SMPs can, if chosen to, provide a clear mechanism or vehicle to facilitate the transfer and utilisation of science within decision making. As we explore implications of SMP2 policy at local levels in the following paragraphs we begin to realise some of the implications of this dubious evidence base.

One key issue associated the limited evidence trail for local stretches of coast is now beginning to arise as local communities start to question the science behind policy options in the SMP2s and, in some cases, contest the science based on personal and community observations. In some areas, coastal communities, previously not engaged in the SMP2 (or even the SMP1) consultation process, have been suddenly become aware of the implications of 'unsavoury' policy options which have been 'lurking' in the SMP2 plans for some time. Such awakenings have arisen through various local and regional actions. For example on the Severn Estuary, where one of the authors has had direct experience, the preparation of the estuary flood risk management strategy by the Environment Agency in the context of the Severn SMP2, required more detailed community engagement and thus scrutiny of the SMP2 policy options, causing communities in the Tidal Severn to question SMP2 wisdom. In Wales, many within the community of Fairbourne were enraged and became mobilised to change the policy when they realised they were living along a coast where the policy HTL would be changed to NAI. This came about through Welsh media coverage following the severe winter storms of 2013/14 which caused unprecedented erosion along significant stretches of coast [44]. In both cases, the heated debate about coastal processes and the questioning of SMP2 policies highlighted inadequacies in the SMP's engagement of the local community and the evidence trail for specific SDs. Whilst in these instances the 'authorities' expended considerable effort and are now engaging and working with the communities, there is cause for concern that, with widespread publicity of these and other similar cases through local and national media, the future credibility of SMP2s may be undermined.

These issues are compounded as coastal change occurs and it becomes likely that some of the SMP2 policy options and particularly the science behind these seem increasingly outdated. Recent physical coastal changes, particularly associated with the severe 2013/4 storms have led some to question the underlying science, particularly the potential influence of some key processes related climate change. Unfortunately, given the timing of SMP2 publication, most SMP2s were prepared under the earlier,

2002 UKCP02 rather than the later, 2009 UKCP09 predictions [45]. As a result of this and the varying degrees of precaution applied in different areas, possibly reflecting different levels of risk acceptable to clients and consultancies, there are some inconsistencies in climate change science and its use across SMP2s. Indeed, this is the main contention in the Fairbourne case [46]. In terms of the land use planning and associated policy environment, there also have been significant changes since the SMP2s were produced [47], which may further call into question the currency of the plans and their scientific underpinning. In particular, there has been a steady increase of legislation and policy relating to environmental as well as flood and coastal erosion risk management, emanating from both European and domestic sources. This has resulted in the development of a swathe of new and revised plans, including Local Flood Risk Management Strategies and Flood Risk Management Plans for selected areas under the Floods Directive (2007/60/EC) and River Basin Management Plans under the Water Framework Directive (2000/60/EC), both of which have invested heavily in a strong evidence base for decision-making (for example, [48]). In such an extremely complex policy sphere with such priorities for plan production and revision, there may also be concerns that SMP2 policy, particularly if questionable, may be overlooked or indeed become superseded.

Currently SMP2 plans are deemed to be adaptive, 'live' documents [42] designed to address coastal change and new 'evidence' as it emerges. Whilst new emerging knowledge of coastal processes is being fed directly into the design of specific coastal defence schemes, SMP2 documentation on the Coastal Group websites remains 'static'. As government advice currently suggests that SMP2s should inform other key decision-makers and planning processes, notably terrestrial land use plans and the newly emerging spatial marine plans, this may be an issue. Whilst the terrestrial planning community has been slow to engage with SMPs, recent studies (for example, [49]) suggest more acknowledgement of SMPs in statutory land use planning policy over the last five years. As these plans will define the pattern of new development in coastal areas, if these plans take SMP2 policy options at face value, prescriptions for new development may be at odds with current scientific understanding. Will there be a 'Chinese Whispers' effect as the 'science' gets 'translated' into different policy spheres or will the evidence trail required for development control decision-making cause further unravelling of the scientific base of the policy options? Such issues are being compounded by the view that SMPs, given their strategic nature, should merely provide a 'direction of travel' rather than prescribed policy (Parr, in [50]). Such a situation could see these documents become 'policy-based evidence', rather than what has been the professed aim that these 'scientific and evidence-based' plans that can lead to improved management of the coast over the longer-term.

6. Conclusion

This study has provided the first structured quantitative analysis of the scientific underpinning and transparency associated with key policies dictating the future of the coastline in England and Wales, building on more qualitative reviews and critiques such as those by Nicholls et al. (2013) [38] and Pontee and Parsons (2012) [51]. Based on a selection of first and second generation SMPs, the study has queried the visibility, clarity and transparency of the evidence base rather than questioning the validity of the preferred policy options themselves. Whilst the SMP process has improved the evidence base and understanding of regional-scale shoreline processes, this study points to a rather mixed performance with distinct issues relating to the transparency of the science informing policy at the local, SD level of coastline. Given government guidance, this is somewhat surprising. However,

as we have been able to identify elements of 'good' practice within the reviewed SMPs for all our criteria, this study does suggest that a clearly articulated science-base of local policy is possible.

Inconsistencies in performance relate more to the different approaches of the various consultancies preparing the plans rather than the nature of the coasts themselves, the types of policies or indeed the date of government guidance informing plan development. Even with a requirement for Strategic Environmental Assessments (SEAs) and Appropriate Assessments under the SEA (Directive 2001/42/EC) and Habitats Directives (Directive 92/43/EEC) for more recent plans, this does not seem to have improved quality from the perspective of our criterion-based approach. This suggests a need for a more thorough quality assurance process at national level which includes evaluation of the transparency of the decision-making process throughout the plans. Whilst a further formal review of shoreline management plans is potentially due within the next five to ten years [52], the 'live' status of SMPs demands clear 'interim guidance' to ensure any modifications to the evidence trail for the SMPs is documented clearly for all audiences, including local communities. Care will be needed to ensure that expectations are not unduly raised. The current format of SMPs, following the government's highly prescribed approach and the definition of distinct time periods for implementation, has created expectations with regards to the presentation and synthesis of information at the local scale. However, this is rarely achieved in practice, and given the resources available, may be unrealistic [50]. As a result of this scientific pathway deficit, issues arise where 'third parties' (i.e. those outside the Coastal Group) start scrutinising the plans and querying whether they are fit for purpose.

Whilst shoreline management plans and the process under which they were developed are somewhat unique to managing coastal risk, there are clearly lessons here for any planning process which seeks to be scientifically robust, adaptable and transparent. Some of the issues of downscaling regionally based data and information to local levels where on-the-ground hard decisions have to be made, will no doubt resonate with other planning systems. The need for clear documentation of evidence which is proportionate to risk, cost-effective and timely is no easy task. However, this is ever more important given current public sector downscaling and associated staff cuts, jeopardising the internal 'understanding' of the science-policy pathways and with the potential to perpetuate a Chinese Whispers effect.

Finally, it is interesting to reflect on the success of our criteria-based approach for evaluating the scientific pathway and underpinning of coastal decision-making in the SMPs and to consider the wider implications for other plans. Our approach provided a clear snap shot of the status of the scientific underpinning of the plans and demonstrated that it was possible to differentiate between the quality of a range of related aspects for a wide selection of plans. Whilst there were some elements which were specifically tailored to the SMP2 process, the criteria and the process for isolating key elements of the plan outputs for review, could be easily applied to other types of plan. Whilst qualitative studies analysing the processes of co-production and brokering of knowledge are more commonplace in the science-policy literature, the authors suggest this type of study can provide a useful underpinning to these studies as well as a baseline for future reference and inter-plan comparison.

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