Beach management plans for mixed beaches: Review and ways forward

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Introduction

Over the last two centuries, the predominantly mixed sand and gravel beaches (termed shingle beaches) in Southeast England have become increasingly managed to maintain them in size and position as they often form the only defence against coastal flooding and erosion. Local approaches to management have led to problems along neighbouring frontages leading to current local management practices that take little or no account of those either side or even further along the coast. In most cases management is required to implement the Hold the Line policies of Shoreline Management Plans (SMP2) with the broader management strategy (groyned or open beach) usually defined through more detailed Coastal Defence Strategies. There exists a good understanding of the general beach material movement at all of the frontages, especially as many of these have a long history of management with a basic set of historic annual monitoring data that goes back to the 1970s, and, at a better level of detail and accuracy, since 2003 (CCO 2008).

A review (Dornbusch & Cargo 2011) that extends an earlier assessment (Dornbusch 2008) has been carried out of formal documents (Beach Management Plans) and non-documented practice for >25 management sites covering >130km in Southeast England with both length and number roughly equally divided between Local Authorities and the Environment Agency as the Operating Authority (Figure 1). The distribution of BMP frontages as shown in Figure 1 reflects the distribution of shingle beaches in Southeast England, their role in providing flood and coastal protection and their potential for short term change due to wave and tide conditions. As a consequence the sheltered frontages of the Solent, the Isle of Wight and frontages further to the West do not show many sites.

Compared to sand beaches, volumes required for recycling, bypassing of inlets or maintenance recharge are small for the individual frontage. For the entire frontage shown in Figure 1 >300,000m³ are recycled, >50,000m³ are added through recharge and a significant amount of reprofiling is undertaken; all at a cost in excess of ~ £2.4m on an annual basis.

Beach Management Plans (BMP)

BMPs received a brief mention in the first edition of the Beach Management Manual (Simm et al. 1996). The 2nd Edition of the Beach Management Manual (Rogers et al. 2010) has extended its guidance on BMPs and is devoting an entire chapter to beach management. It contains an exhaustive table of content to be addressed in BMPs as a draft template. While such a comprehensive BMP might be appropriate for frontages with annual management costs of several £100k, for those frontages where only a couple of thousand cubic metres are recycled every few years this seems disproportionate.

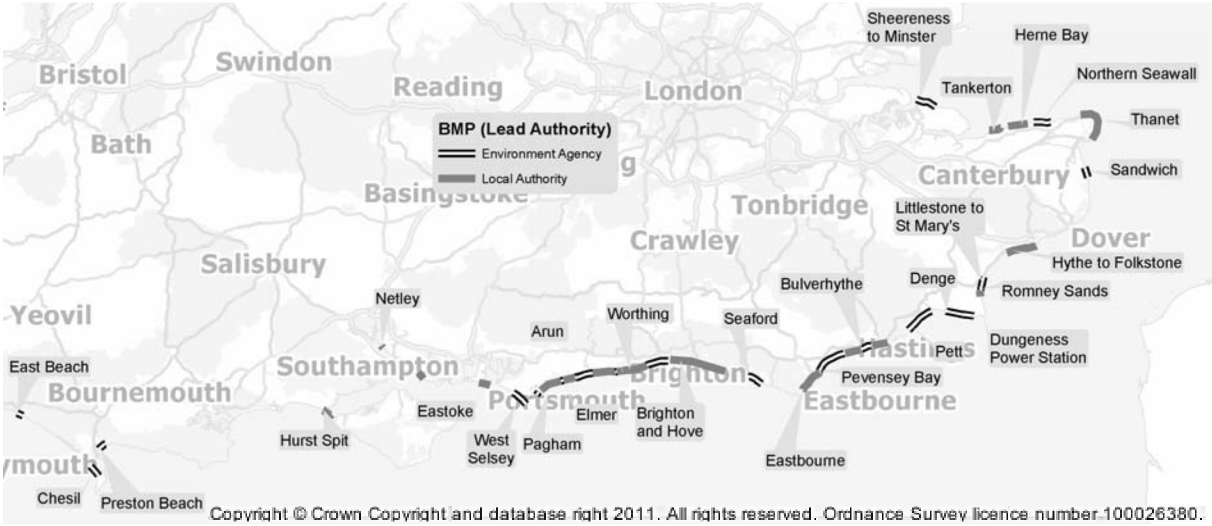

Figure 1 Locations of Beach Management activities in Southeast England.

This paper, based on the analysis of a large number of BMPs and non-documented beach management activities, puts emphasis on the evidence base of BMPs and how this can be assessed and modified in the cycle of design, monitoring and evaluation (Figure 2), which has led to the following definition or vision for BMPs.

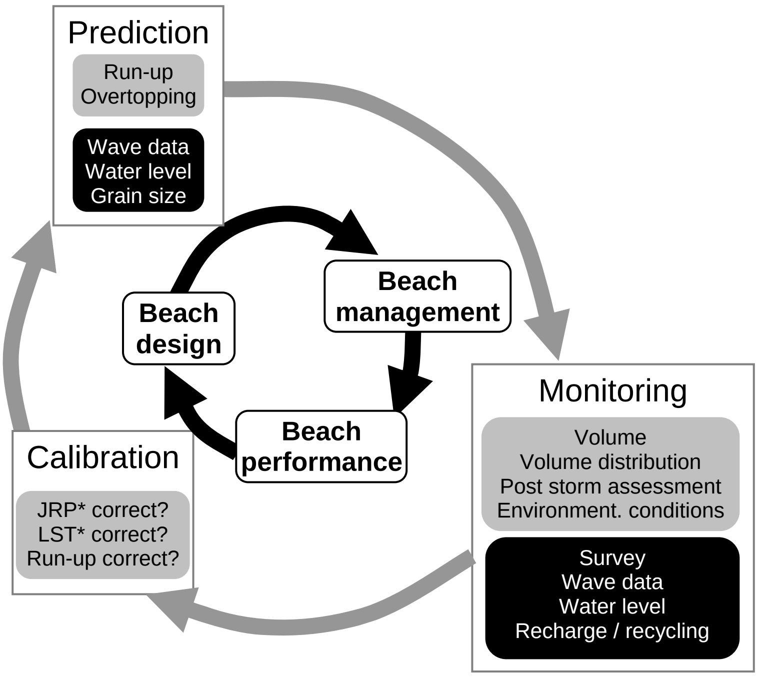

Figure 2 Schematic of the feedback relationship between beach design, management and performance, and prediction, monitoring and calibration of design predictions. Black boxes show examples of primary data that feeds into the process and grey boxes show derived data and data analysis that drives the cycle. * JRP = Joint Return Probability, LST = Longshore Transport.

Beach Management Plans provide an accountable and transparent methodology for managing beaches as coastal defence assets based on risk information that derives from scheme design, monitoring and scientific/research input with the aim of managing the frontage in a sustainable way.

Here, sustainability refers to managing the beach (or the beach plus other defences) as a coastal defence structure in a cost effective way to the right standard of protection to address the risk of flooding or erosion with the least environmental impact so as to enhance vegetated shingle habitat opportunities. While beaches in many locations along the coast also provide a significant amenity, a clear distinction needs to be made between requirements for flood and erosion protection and any additional amenity requirements.

Review Results

The review for the first time collated and summarised any existing beach management documentation together with ad-hoc information at a regional scale allowing for a large scale overview. Table 1 gives a high-level breakdown for the managed frontages, highlighting that the first documents have been produced as early as the mid 1990s; only three of the documents are regularly updated.

Table 1 Breakdown of number or frontages, length of frontages and document year by Operating Authority (* EA = Environment Agency, LA = Local Authority)

		Operators			
		EA*	LA*	Private	**Sum**
Number of frontages	Ad hoc	6	10	1	17
	Formal Plan	14	7		21
	Sum	**20**	**17**	**1**	**38**
Length of frontages	Ad hoc	17	37		54
	Formal Plan	57	27	2	86
	Sum	**74**	**64**	**0**	**140**
Document production year	1996	1	2		3
	1997	1	1		1
	1999		1		1
	2003	1			1
	2006	2			2
	2007	2			2
	2008	1	1		2
	2009	4			4
	2010	1	2		3
	2011	1			1
	Ad hoc plans or no date available	6	10	1	17
	Sum	**20**	**18**	**1**	**38**

Due to the large variety in format and content of documents an attempt was made to extract information from each document to fit under specific headings including an overview of the risk, the physical parameters driving the design (wave and water level parameters, grain size, longshore transport), design parameters (e.g. crest width & height, slope), trigger levels for intervention, regular and emergency management activities, the recognition of vegetated shingle habitats and costs.

Where possible, information was also collected for the design parameters and for parameters as used in practice. Most of this information was incorporated into a geo-database allowing for the spatial interrogation of the data (an example is shown in Figure 3).

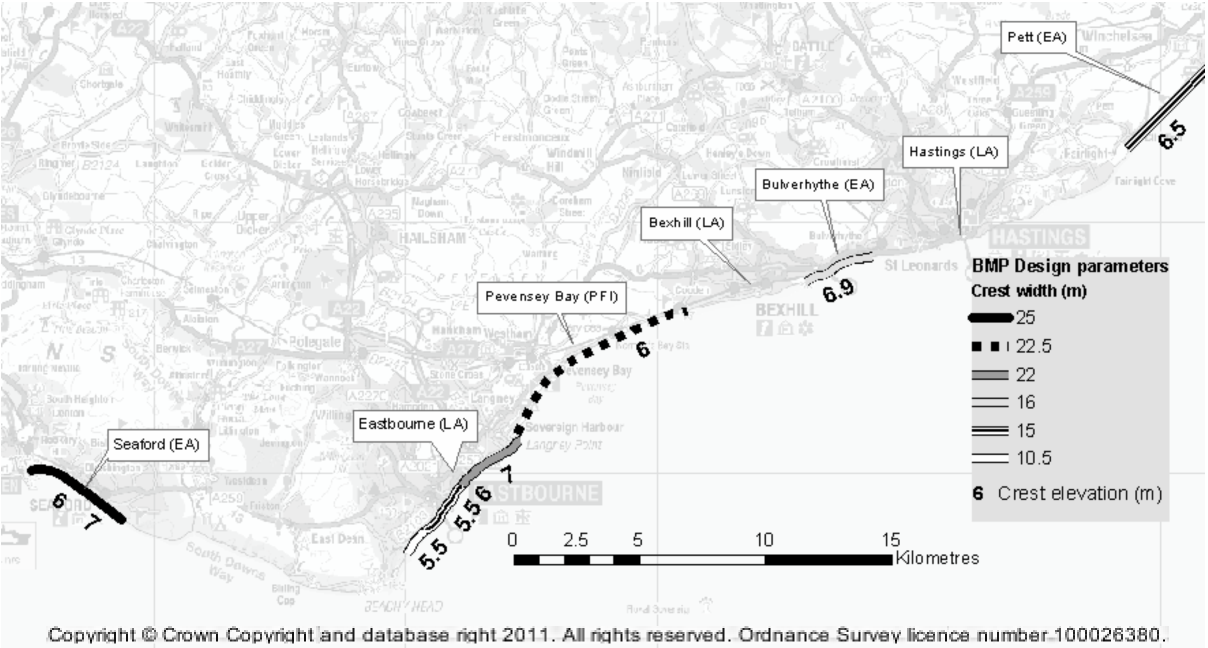

Figure 3: Example mapping of BMP parameters showing design crest height (numbers) and design crest width (line symbols). Abbreviations in parenthesis are for the Operating Authority: EA = Environment Agency, LA = Local Authority, PFI = Long term contract (2000 – 2025) for contractor to manage for EA un Public Finance Initiative.

While the more recent BMPs in particular provide information within a content framework that resembles that suggested in Rogers et al. (2010) the main shortcomings in the overwhelming majority of documents or undocumented practices reviewed relate to:

- basic modelling, assumptions and data that went into the design,
- environmental considerations in relation to habitats,
- the use of coastal monitoring data,
- lack of considering large frontages beyond administrative or scheme boundaries,
- lack of review following initial project implementation

Basic modelling assumptions and data

From the outset, many BMPs lack in definition by failing to identify whether it is the risk of overtopping, breaching or undermining to which a given standard or protection applies. In the case of overtopping, there is rarely an indication as to what amount of overtopping might be tolerable and why. With rising ground behind the beach, the overtopping for say a 1 in 200 year event should for example be more linked to structural damage than risk to pedestrians as it seems unlikely that a promenade will be used under these conditions.

Overtopping calculations for mixed beaches are inherently uncertain and there does not exist a proven method for its calculation (the EurOtop manual (2007) only refers to shingle beaches and provides a very simple formula that has seen no field testing). Nevertheless, design parameters (crest height, crest width and beach slope) are reported in BMPs and in the more recent ones, reference is linked to EurOtop (2007), however, not giving any more details as to formulae used. This lack of overtopping ro even run-up calculations relates to shingle barriers, shingle beaches in front of vertical seawalls or in front / overlaying sloping concrete or rock revetments. There is also a lack of clarity about the parameters that would be needed for any calculation: such as wave data, water levels and beach characeristics like grain size or elevation of the beach toe. Sometimes, joint return probabilities (JRP) have been used for wave and water level parameters, however, these do not necessarily take wave direction into consideration and bi-modal waves are not considered. parameter Similarly, there is usually uncertainty as to whether wave parameters used are those for an offshore / nearshore location, or relate to the depth limited conditions at the beach toe. This design approach leads to some spatial inconsistencies when for example comparing crest height for beaches of different exposure (Figure 3). The southwest facing beach at Seaford not only has the highest exposure due to the predominant storm waves coming from the southwest but also because the beach toe of the shingle barrier is located at -4 to -5m Ordnance Datum (OD) which is well below Mean Low Water Spring (MLWS at -2.8mOD). Very similar crest elevations are also found for beaches facing less exposed ESE to SSE directions, and where the beach toe is usually well above MLWS. Wave conditions closer inshore are usually transformed from offshore modelling points, or from wind hindcasting for older BMPs. Use of recorded data under the Strategic Regional Coastal Monitoring Programme (CCO) is rare.

Coastal habitat considerations

Especially the more recent BMPs list European and national nature conservation areas within or adjacent to the BMP frontage, however, and assessment or even the recognition of the impact of the advocated beach management activities on existing vegetated shingle or the potential for this habitat to develop (Doody & Randall 2003) is very rare. While some BMPs advocate habitat monitoring amongst the recommendations for monitoring, in general there is no further guidance as to how, when or by whom this might be carried out.

Use of coastal monitoring data

The region considered in this review has been monitored since the 1970s through annual beach profile surveys based on photogrammetry that have been drawn into a more robust programme of beach topography, bathymetry, wave and water level monitoring since 2003. In general, a very limited amount of this data has found its way into BMPs, either in the form of supporting the design of beach parameters or by using it to review and assess design parameters of management activities. Continuation of monitoring is universally recommended, yet many of the BMPs do not take the opportunity to fine tune the regional monitoring programme to meet the specific needs for that frontage

Consideration of longer frontages

Along several stretches of coast, the authorities responsible for managing the beach change every few kilometres (Figure 3). As a consequence, and because many BMPs have been initiated following capital schemes, there is usually no recognition of frontages either side, despite there being an exchange of sediment across boundaries or the potential to combine works.

Review and update of BMPs

Only three BMPs are regularly updated but there is a general absence of evaluating design conditions against monitoring data (for example where do storms experienced fit in with JRP curves) or update predicted longshore transport rates with those measured and with any recycling volumes. The review approach described by Bradbury et al (2009) is uncommon, yet highlights a clear need to review and update design conditions. As BMPs frequently do not include any information about anticipated costs, there is also no review of predicted and actual costs that could inform whether the management practices achieve the assumed benefit cost ratio.

Common large scale issues

The review, together with a previous smaller scale project (Dornbusch 2008) has highlighted some common large scale problems associated with sediment sinks. Major longshore transport pathways are interrupted by rivers and large structures causing accumulation against them. One pathway from Selsey to Brighton is interrupted by the Rivers Arun and Adur with the terminal stop at Brighton Marina. The cell from Eastbourne to Pett is interrupted at Sovereign Harbour with a final stop at Hastings. Finally, the cell on the eastern side of Dungeness has a final stop at Folkestone Harbour. The frontages between these obstacles are too long to carry out land based recycling in a cost-effective and sustainable way. On the other hand, bypassing these obstacles only increases the pressure on the downdrift obstacle to deal with additional beach material accumulations that lead to the blockage of outfalls (Brighton Marina) or has negative impacts on harbour activities (Shoreham Harbour, Hastings Harbour (Hastings Borough Council 2010)).

Recommendations

The 2010 Beach Management Manual (BMM; Rogers et al. 2010) contains "in (Box 8.1) […] Specific guidance on the preparation of BMPs for England and Wales, prepared in discussion with Defra and the Welsh Assembly Government (WAG)". While this provides an all encompassing framework of what potentially could be included in a BMP the shortcomings identified have led to the following recommendations that should be used as additional guidance that particularly addresses the clarity of the BMP as a single stand-alone document to provide an accountable and transparent methodology for managing beaches as coastal defence assets.

Given the well established needs for beach management, there is a wealth of data contained in the Strategic Regional Coastal Monitoring Programme, SMPs, Coastal Strategies, schemes and beach management activities. BMPs do not therefore have to start from a state of ignorance. Most importantly, there is often some data available to compare the performance with the initial design and with neighbouring or similar frontages in Southeast England.

Unless it is considered to manage a frontage radically differently, for example by adding a groyne field to an open beach or otherwise changing the general principle of management, there seems little merit in starting with the 'Beach Management Scheme Appraisal' outlined in the BMM (Rogers et al. 2010). Instead, the BMPs for the frontages considered should focus on what the BMM calls an 'Operational BMP' but extend it to include the evidence base for why the operations are carried out and using the content suggested below.

The following recommendations are made for the core of an operational BMP which could be supplemented by relevant items from the framework for a BMP listed in the BMM. This should ensure that the management activities and decision making are based on transparent information, based on monitoring and beach performance data; it should also inform and allow for a periodic review of the decision making (Figure 2). In addition, a BMP needs to be in proportion to the average annual costs for the actual management. An all encompassing BMP might be appropriate for frontages with annual management costs of several £100k. For those frontages where only a couple of thousand cubic metres are recycled every few years a more concise, but nevertheless evidence based and transparent BMP may be adequate.

Background: A description and history of the site, including schemes, incidents, general evolution, reference to SMP and Strategies, habitats and environmental constraints and linkages with neighbouring frontages.

Drivers: The drivers are the flood and/or erosion protection, ie the number of properties at risk or any other benefit resulting from protection (e.g. protection of freshwater habitat on the landward side). This will result in the determination of the standard of protection (SoP) required. The SoP should be calculated separately for overtopping and for breach and should take variations of the risk and topography into account. At Seaford (Figure 3) for example, low lying and rising ground alternate several times along the frontage and applying just one SoP for the entire frontage may not be appropriate. The SoP for overtopping should clearly demonstrate the acceptable and unacceptable rates of overtopping depending for example on the back shore type (e.g. promenade, road, wide beach, houses) and its use (e.g. essential road, recreational promenade). This data should be consistent with the Shoreline Management Plan or Coastal Strategy, where these exist.

Physical input: These are the conditions on which design and intervention are based. For better comparison and transparency, these conditions should refer to inshore conditions. Wave heights should consider the breaker wave height rather than offshore conditions that for the frontages considered often bear little relationship to the depth limited or sheltered conditions at the beach. The new national Flood Boundary Conditions data set (McMillan et al. 2011) provides a homogenous and easily accessible data base for water levels. Additional input conditions like grain size description of the beach (and how this was determined), foreshore profile and level of the beach toe need to be included as well. Any modelling or simpler formulae used to derive, for example breaker wave heights and joint probabilities, should be documented in such a way that any results are transparent and the way they were arrived at can be followed and easily duplicated.

Design process and results: The processes required to derive a design profile that satisfies the appropriate SoP identified under point 2 above needs to be clear and transparent and any uncertainties need to be clearly stated. Any modelling needs to be cross checked with coastal monitoring data (e.g. post storm surveys) to provide a reality check – if not a calibration – for the models used. A design that leads to an oversimplified and unrealistic beach cross profile with a horizontal berm of a certain width at a certain elevation and uniform frontal slope needs to be compared with the natural beach profile behaviour under storm conditions. Natural behaviour might involve the creation of a storm berm at an elevation above the design berm; this would have implications for overtopping which should be explored. Beach reprofiling may lead to 1) compaction, 2) habitat destruction and 3) obliterates any sediment sorting that has taken place. 1 and 3 are likely to increase cliffing, when the only reason for reprofiling is often to remove cliffing.Trigger levels need to refer to changed SoPs and in locations where inshore waves are depth limited, foreshore levels should be included as these will have direct impact on input parameters. The result of points 2 to 4 should provide an auditable trail of evidence – that can be easily reviewed at intervals (e.g. how well a BMP performs against physical conditions experienced over a certain interval). This provides the framework for development of a design beach configuration. The consequence of varying this configuration (with respect to changing SoP), or the parameters that went into its calculation, can be easily followed.

Review of management activities: Given that management has happened for many years at most of the sites, and that the existing BMP documents have been rarely reviewed or updated, a review of activities and associated costs should be included. Particular emphasis should be given to the impacts of existing management activity on the beach, habitat (vegetated shingle) and how management activities need to change to improve the habitat. Where beach management is carried out for amenity purposes (for example the common practice of smoothing the beach in spring) this should be put in perspective with damage that this might cause to existing habitats or its impact on the potential for habitat to develop.

Proposed Management activities: Points 2 to 5 provide the background against which the proposed management activities should be based. All activities should be linked to trigger conditions that are themselves linked to SoPs and to monitoring of the beach. Although, for example, regular recycling of a given amount of beach material is easy to plan and budget for, it might not be necessary. Though present funding arrangements seem to favour regular works, if the case is made across many BMPs that more flexibility would be more cost effective, then funding arrangements need to change.

Monitoring activities: Points 2 to 6 should be used to determine monitoring requirements divided into those that can be accommodated within the Strategic Monitoring Programme and those that might be more site specific. Any site specific monitoring should feed back into the Strategic Monitoring Programme data collection. Monitoring should address the individual beach and its problems. For example, some beaches in this review have substantial subtidal portions (e.g. Chesil, Seaford) which cannot be surveyed easily from land. The benefit cost of surveying these differently needs to be assessed.

Costs: This section should include a breakdown of the costs for managing the beach, including any works and time spent by the operating authority for the management and analysis.

Analysis and review: This closes the circle by assessing the performance of all activities (design, management, monitoring and costs) against the risk and the SoP provided. A programme of BMP reviews should be made and published in the Action Plan for the relevant SMP.

Ways forward

A set of hierarchical (**Error! Reference source not found.**) and prioritised BMPs has been proposed and will be carried out over the next two years in a project delivered in partnership between all Operating Authorities. Prioritisation for frontages was based on present day annual spend, the existence and date of a BMP, the presence of, and initial assessment of design and trigger parameters and the perceived benefit from combining a frontage with neighbouring ones both in relation to sediment pathways and combining beach works.

However, improving individual BMPs or combining them based on sediment pathways and to achieve economies of scale by combining beach works will only provide limited benefits unless funding and governance structure for beach management is changed at the same time. Funding for maintenance activity from Government Capital Grant (FDGiA) is usually restricted to a short frontage and applied for and granted on an annual basis that is tied to the financial year (April to March). Application for funds has lead-in times often exceeding 12 months. These factors make it impossible to carry out beach management on a 'needs only' basis, both spatially and temporarily, which is likely to lead to funding applications that relate to the 'worst case'. Once the funding is granted, there is no incentive not to spend the funds as this might prejudice future funding. With the financial year ending in March, just short of the highest equinoxial spring tides (usually end of March / beginning of April) and still within the period of the stormy winter season (e.g. severe storm on 11th March 2008), chances are that funds will have been spent unnecessarily prior to an event just to ensure that they are spent within the financial year.

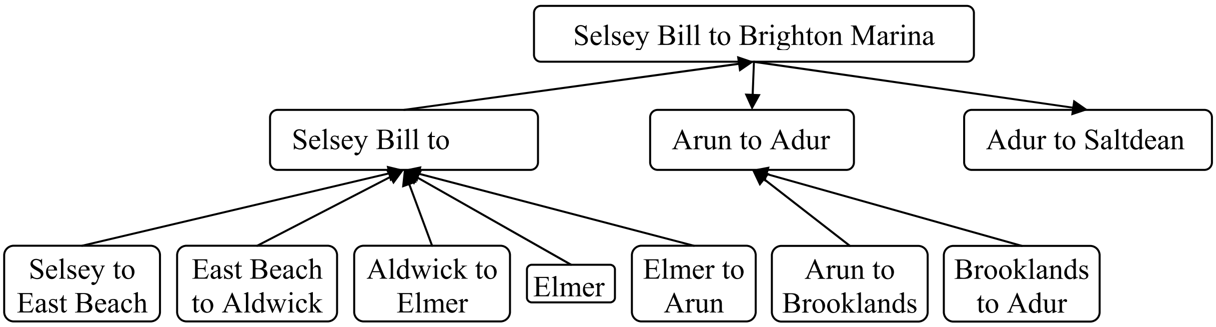

Figure 4: Example of hierarchical subdivision of frontages.

Pool funds in time:
For beach management that is carried out on a needs basis, annual variation can be in the range of between -40 to +25% of the average (pers. com. PCDL 2010). Such savings can only be achieved / higher expenses can only be accommodated, if funds can be carried over between financial years so that savings can be used to build up for years that require higher spend.

Pool funds regionally:
With frontages managed within the Southeast having vastly different storm and surge exposure parts of the annual funding requirement variations could be absorbed through regional variations so that some flexibility could be achieved without the need to pool funds in time. For example, North Kent suffers from northerly to easterly waves and from North Sea surges; there is a quite different wave exposure for Seaford compared to Eastbourne to Hastings.

The largest benefit with regard to flexibility of funding beach management would be to allocate funds on a regional (or Coastal Group) basis and allow for these funds to be carried over into following financial years. This approach would require for the funds to be managed by a group of Operating Authorities that co-ordinates beach management on a needs basis. Such management requires robust BMPs to identify needs and assess risks of activities being carried out or not for individual frontages. Apart from improved management under normal conditions this closer co-operation between Operating Authorities would also benefit emergency planning and activities to recover from extreme events.

Finally, implementing the recommendations will require additional funds for ‘yet another plan that does reduce funds available for carrying out work on the ground’. Presently, the answer to a perceived shortage of sediment along a frontage is to recharge (recent examples for 2010-11 are Eastbourne and West Wittering with combined costs of £6m). In both cases recycling across frontage boundaries could have been a more sustainable solution at a fraction of the costs, but either the lack or the narrow focus of a BMP has lead to the recharge option being promoted. Apart from significant post project beach management cost savings, the project itself is designed to deliver BMPs at a fraction of the costs of recent BMPs prepared by engineering consultancies that have cost between ~£8,000 and £10,000 per km. This will be achieved by using Operating Authority staff – many of which are involved in the Regional Coastal Monitoring Project – in working on these BMPs providing direct input of existing information and local knowledge; this will also help maintain and improve staff skills. Comparatively small scale investments into R&D on wave run-up predictions and alternative ways to land-based recycling will benefit all BMPs and achieve disproportionately large benefits. The project budget is < 10% of the annual beach management budget so that the costs of the project to update BMPs and address the present shortcomings is likely to be recovered through savings within a very short period of time.

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