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Decision making in dune management: theory and practice

Davies, P.[1*], Williams, A.T.[1] & Curr, R.H.F.[2]

[1]*Centre for Environmental and Technological Research, School of Applied Sciences, University of Glamorgan, Pontypridd, Wales, UK;* [2]*Faculty of Applied Sciences, College of Higher Education, Newton Park, Bath, Avon, UK;* [*]*Tel. +44 443 482280; Fax +44 443 482285*

Abstract. Effective decision making depends upon the availability of quality information. Procedures involved in assessing dune vulnerability and protection require monitoring of sporadic processes and information must be collected from many discipline sources. In particular, a significant challenge to strategic management is recognition of subtle discontinuities which could undermine the long term stability of the dune system. These changes may be irregular and/or non linear requiring managers to be aware of existing parameters, patterns and emerging discontinuities. A range of components within the system should be measured on a systematic, temporal and spatial basis. An environmental *checklist* is a useful management technique which systematises information, so that strategic objectives can be made operational and achievable. Problems can be identified and solved with this methodology particularly if it is incorporated into a **W** problem solving model. The checklist procedure proposed in this paper has been developed and tested in field conditions for a range of north-west and south-European dune systems. Whereas a universal *checklist* applicable to all systems is utopian in aim, intra and extra-regional comparisons can be undertaken with only minor modifications of some components. Parameters covering site and dune morphology; beach condition; surface character of the seaward 200 m of the dunes; pressure of use and recent protection measures are the basis for calculating vulnerability and protection indices. The balance between these indices can be determined, analysed and form the foundation for future informed management decisions.

Keywords: Checklist; Dune; Management practice; Management theory; W-model.

Introduction

Change in coastal dune systems is generated through interaction between the objective and subjective variables constituting the environment. Objective variables are those parameters accurately measured within the physical environment, for example beach width, vegetation cover, dune area. Subjective variables are set within the complex of socio-economic and cultural factors influencing system utilisation; they are more difficult to quantify. An effective management strategy depends upon the availability of essential information which is objectively measured if possible rather than anecdotal. The quality of decision making suffers if data on the system's controlling parameters are not systematically collected and analysed. This is particularly critical in assessment of dune vulnerability and determination of dune management policies because of the range of processes operating, some of which are sporadic in occurrence. Policy management relates to diagnosis and direction setting. To be effective and rational, dune managers need to be aware of a broad range of useful knowledge, as well as suspicious of claims that promise too much. Managing man-nature relationships involves "mutual interactions and feedback based on power differentials, conflicting values and competing interests and expectations" (Boehmer-Christiansen 1994, p. 84). A procedure of structured data collection is needed that is incorporated into the management policy with clear objectives. The aim of this paper is to set structured data collection within the context of a theoretical perspective; currently the latter is sadly lacking within dune management strategies and procedures.

Strategic management - theory and practice

Strategic management refers to the process of making and implementing strategic decisions. Johnson & Scholes (1988) identified three main elements to the activity: *strategic analysis*, where managers seek to understand the context of the system/organisation; *strategic choice* i.e. choosing between possible courses of action; and *strategy implementation* whereby the chosen option is put into effect.

A strategic approach to dune management is desirable since it is a means by which factors influencing the long term behaviour of the dune system can be identified and management responses initiated. Management theory identifies the inexact and non-scientific nature of policy making (Lenz & Lyles 1989) and the making of strategic decisions often involves considerable uncertainty and ambiguity (Donaldson & Lorsch 1983). It can be seen as a process consisting of analytical techniques and judgement with elements of both arts and science. Decision making should be rational with planning models constructed around:

- evidence obtained from environmental monitoring;
- the setting of clear objectives;
- evaluation of strategic options.

It is very important to distinguish between the 'hard', more quantitative natural sciences and the 'soft', more contextual social sciences when considering management policies. Most authorities want hard facts adopting the (false) belief that numbers are more meaningful than ideas, probabilities and values (Funtowicz & Raveltz 1990). Quinn (1980) believed that managers achieve strategic change through environmental monitoring, a process termed 'logical incrementalism', i.e. a learning and readjustment sequence by which policy is kept in line with environmental change. It assumes a tension between the identified environment and the reality of management policy and practice. This ideal may not be achieved however because the environment is frequently not viewed objectively (Asch 1989). In addition, Johnson (1989) has argued that whilst managers may see themselves as managing in such a manner, small shifts in management policy i.e. conscious incremental change, will not necessarily keep pace with environmental change. 'Strategic drift' sets in and at some stage a more fundamental policy realignment becomes necessary. Further, Bowman & Asch (1987), stressed that rationality was not a concept that could be taken for granted, since problems of information quality, goal diversity and managerial psychological make up can lead to non-rational decisions. Whilst rational techniques are available to assist choices they cannot make those choices because of the presence of qualitative variables within the environment. Indeed there are dangers inherent in trying to make the analysis too rational since the approach could become inflexible, formalised and excessively quantitative. Such management policy, made entirely on the basis of hard facts, tends to lead to 'paralysis by analysis' (Lenz & Lyles 1989). Nevertheless rational analysis should be a significant management aim since it forces decision makers to confront the value judgements that need to be made, a conclusion highlighted by Bowman & Asch (1987), and there is need to review the basic assumptions periodically.

Mintzberg & Waters (1989) have described a number of strategic planning types, for example:

1. '*Deliberate*': requiring an environment that is perfectly predictable, totally benign and under full control of the manager. In practice there is considerable uncertainty and ambiguity with regard to the operation of most systems and managers have to call upon experience and judgement.

2. '*Imposed*': would be the appropriate response to changes of environmental parameters where the system is largely understood and predictable.

3. '*Umbrella*': applicable where elements of the environment are uncontrollable and unpredictable. Only general guidelines for behaviour can be set in such contexts i.e. overall boundaries are defined within which some parameters can be manoeuvred. This strategy requires the maintenance of a delicate balance between proaction and reaction.

4. '*Emergent*': appropriate where the environment is even more unstable or complex to comprehend. Such systems require open, flexible and responsive management styles.

Within any of the strategies adopted, it is important to have clear objectives, focused intentions and quality information.

Managers who adopt formalised, structured and systematic data collection and analysis should achieve more successful outcomes. Kepner & Tregoe (1976) argued strongly for such an approach to problem solving and decision making in general. Systematic and structured data collection is economic in time and effort and can be employed by both individuals and groups. Taylor's (1961), nine step eclectic PakSA problem solving technique identified the need to 'get', 'organise' and 'refine' knowledge. The emphasis is not on ideas, but the gathering of information which is reliable, sufficient, impartial, consistent, comprehensive and of predictive value. Data should be organised into a logical format particularly where problems are complex. Taylor's (1961) approach is still regarded as a valid problem solving technique.

In the environmental monitoring and knowledge gathering contexts, *checklists* are a useful approach (see below). Repeated application of such a procedure with its continual analysis and refinement of data can be easily incorporated into a **W**-model of problem-solving (Fig. 1). The latter has its roots in Zen Buddhist philosophy with a belief that insights can be achieved by concentration on simple facts. The **W**-model is an iterative process which involves successive phases of conceptual thinking, and field testing, evaluation and modification to achieve a final verified approach - steps A to H in Fig. 1. The name is derived from the visual pattern (W) associated with this sequence of problem solving. With respect to dune systems, the procedure is shown in Fig.1 and is a useful methodology for systematising information and problem solving, which sprang from the KJ-method for structuring anthropological field data (Anon. 1994).

This paper argues that orderly and systematic ap-

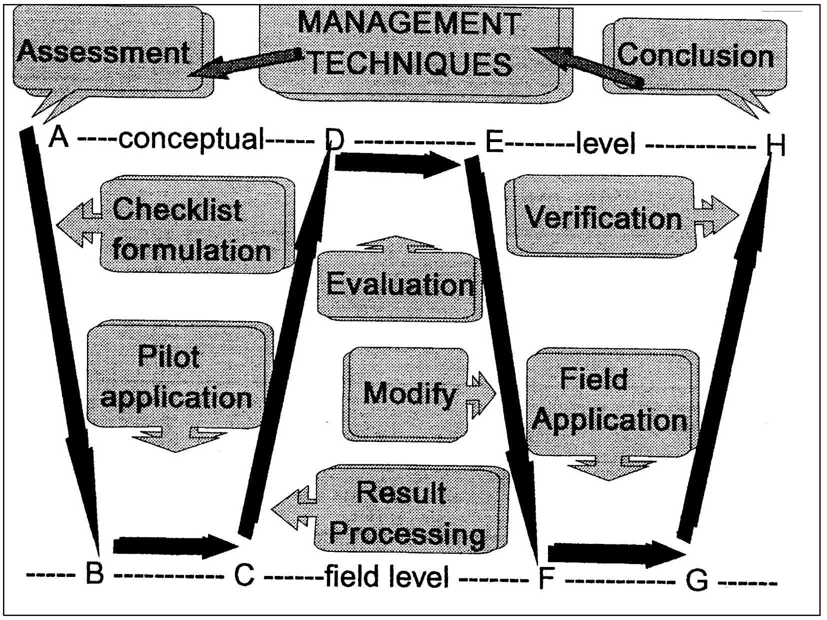

Fig. 1. The **W**-model of problem solving.

proaches to data collection *via checklists* should be incorporated into the process of strategic decision making and dune management. Appraisal of dune environment parameters is vital for strategy formulation, and given the complexity of coastal dune environments it is self-evident that managers should consider as many parameters as possible. Nevertheless, information will never be available in the quantity and quality required to achieve a totally comprehensive analysis, and the authors are not tied to the implicit belief that there is a direct correlation between quantification and certainty. It is necessary and valid to accept on occasions, supposedly qualitative judgements concerning the present and future dune environment Management strategy should reflect harmony between qualitative and quantitative variables and can be represented by the familiar Tao symbol. This has been allowed for in the *checklist* procedure identified below. Whilst both objective and subjective judgements are incorporated into the *checklist* approach of this paper, it was evident during the pilot stages of developing the procedure that a high level of consistency and replication was possible even when used by managers from a variety of disciplines, or by individuals, or by groups.

When applied, the procedure is simple, even mechanistic, but it is evident in this and other contexts (Hogart & Makridakis 1981) that such procedures can be used to make accurate short-term forecasts and out-perform more theoretically elegant and elaborate management models. This is particularly true when data gathering is set within a time series analysis. The procedure breaks down information into discrete units which are dealt with in sequence, a worthwhile approach, since it can be argued that few decision makers can comprehend much more than a limited and simplified set of interrelated variables at any one time (Bowman & Asch 1987). In essence, an overview of the implementation process involves analysis, planning, management and monitoring.

Dune management

Many different philosophies of dune management exist. Some of these focus on maintenance of existing spatial patterns, attempting to stabilise the dune for that momentary situation neglecting the dynamic character of the system. Wanders (1989) has stressed the importance of recognising the dynamic character of dune systems. Static approaches can put excessive stress on the system and should be avoided. At times, some emerging changes may even be positively encouraged for the well-being of the system. For example, the importance of bare sand is increasingly understood to be essential to resist atrophy in coastal dunes, and if not developed by natural events can be artificially induced in a dune environment. Louisse & van der Meulen (1991) have argued against a ‘static’ approach to the

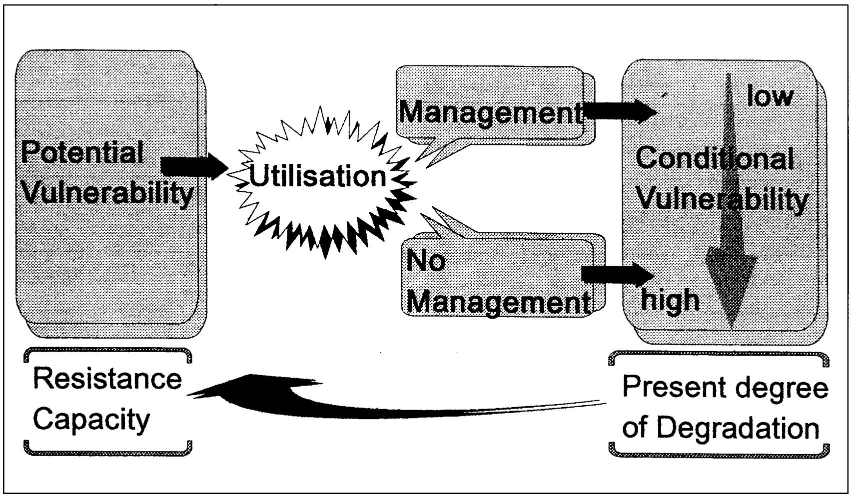

Fig. 2. Dune vulnerability states.

management of valuable ecosystems. They postulated that future policies would allow natural dynamics to occur, reactivating or introducing new ecosystems. Dolan (1972) demonstrated the dangers of resisting dynamic processes and attempting to maintain continuous foredunes and halting overwash processes, since the latter were shown to be essential in limiting dune scrub invasion. Similarly 19th and 20th century dune management in the Netherlands was conservative (Westhoff 1989) with *Ammophila* - planting and afforestation leading to rigidity, petrification, and impoverishment of the environment. It is now widely recognised that a key management objective is freedom of operation of natural processes which may encourage ecological and morphological diversity as the ecosystem is the dominant conceptualisation of nature (Wanders 1989; Cherrett 1989). In fact, the current view of nature is that it is in a state of non-equilibrium (Levin 1989). It is imperative from the above discussion that dune managers be aware of existing parameters and patterns so that emerging discontinuities can be recognised.

In the past most researchers have regarded dunes as vulnerable because of their propensity to show dramatic change under stress. Vulnerability can be defined as conditions causing accelerated erosion, ecosystem decay and an advanced state of degradation with obliteration of the dune surface. This could be induced by natural factors, for example storm damage in Portugal (Alveirinho-Dias et al. 1994); anthropogenic agencies in the UK, where uncontrolled visitor pressure is a significant factor seriously degrading as much as one third of the dune area (Doody 1989); and/or animal impacts, for example excessive rabbit burrowing can destabilise dune vegetation (Westhoff 1989). However such changes are not always negative and much of the diversity in British dune systems has resulted from grazing of wild and domestic animals (Boorman 1989).

As stressed earlier, successful management requires as rational an assessment of the environment as possible, recognising the range of processes operating within the system and the need for data gathering from a variety of discipline perspectives. An obvious paradigm is that "dune management should rest on a clean theoretical basis, in order to be able to present the best possible arguments for the chosen approach" (van Zoest 1992, p. 504).

The dune vulnerability *checklist* of this paper is a structured and systematic procedure which summarises the present condition of a coastal dune. Fig. 2 indicates a range of possible vulnerability states. Potential vulnerability is determined by parameters which constitute the physical environment e.g. geomorphological, ecological, etc. The system may be 'utilised' by human and animal populations. The level of management will usually determine the degree of 'conditional vulnerability'. In most cases it is 'low' where management policies are effective, and 'high' where no management policy presides, leading to extensive degradation. Where the degree of utilisation is minor, a 'non-management' policy may be a rational response e.g, Blea Hill, UK (Williams et al. 1993a). Similarly, a positive sediment budget can mitigate against losses induced by anthropogenic and animal influences e.g. La Coubre, Charente Maritime in France (Williams et al. 1993b) and the scale of management intervention required will be limited. It should be remembered that science interest in environmental problems is not to advance effective policy but to create more knowledge, but there is enormous pressure to give hard consensual answers (Hagstrom 1965).

The Checklist

Checklists are common to many disciplines giving a structured approach to data collection and analysis. For example, they have been applied in scenic assessment of rivers (Leopold 1969), the evaluation of slope stability (Cooke & Doornkamp 1989) and coastline risk analysis (Hallégouët et al. 1984). With respect to this paper the *checklist* is used as a 'problem delineation' procedure (Taylor 1961) in which the major characteristics of the problem are listed, rated and evaluated with respect to dune vulnerability and protection (Meur 1993; Williams et al. 1993a; Bodéré et al. 1994; Davies et al. 1995). The structured procedure can be applied by managers from various discipline backgrounds and has advantages of economies of time and effort. The condition of a dune system may be summarised from topographic and geological maps, air photographs and predominantly field investigation. The *checklist* proforma (App. 1) is arranged in a manner to allow systematic consideration of the main parameters summarising the condition of a dune system. The main categories are:

A. Site and dune morphology;
B. Beach condition;
C. Surface character of the seaward 200 m;
D. Pressure of use;
E. Protection measures.

Utilisation of the *checklist* (App. 1) is carried out by the dune manager as follows. Each of the 54 parameters is considered independently and the rating scale is recorded by ticking the appropriate box in the pro forma. The percentage of the maximum possible rating value can be calculated for each section (Parameter %, Tables 1 and 2). Summation and percentage calculation for all 43 parameters in Sections A - D, enables determination of a site Vulnerability Index (VI, Tables 1 and 2). Similarly, summation and percentage determination for the 11 parameters in Section E (App. 1) establishes an index of recent Protection Measures (PM, Tables 1 and 2). For example in Table 2, the VI index is 63.7% obtained by expressing the total score found in the *checklist* for sections A to D (107) as a percentage of the maximum score possible (168). The VI/PM ratio (Table 1) indicates the balance between vulnerability and managed response, allowing classification of the site as an 'out of equilibrium system', either positive, (value < 0.8), or negative, (value > 1.3) or an 'in equilibrium system', (0.8 - 1.3). These thresholds have been determined from empirical investigation of some 75 sites in a variety of coastal environments in Europe. Their characteristics can be plotted as graphs (Fig. 3). Fig. 3 is constructed by plotting the calculated percentages for sectors A - D along four axes and joining these values. A circle is then drawn representing the calculated percentage found for the Protection Measures at the site. The diagrams graphically present the balance between vulnerability and

Table 1. Dune parameters for some European systems (Numbers rounded up).

Dune system	Parameters (%)						
	A	B	C	D	VI(A-D)	PM	VI/PM Ratio
Portugal							
Cacela	78	50	60	7	44	41	1.07
Ancão	66	72	71	46	64	59	1.08
Barreta	69	44	48	46	37	43	0.86
France							
Kerlouan	64	62	43	61	52	18	2.89
Bon Abri	71	25	40	21	36	67	0.54
Vieux Bourg	71	25	65	39	50	39	1.28
United Kingdom							
Northam	72	42	46	11	38	82	0.46
Croyde	78	47	52	32	49	73	0.67
Porthtowan	84	33	50	43	51	36	1.41

Table 2. A Detailed breakdown of the checklist as applied to the Ancão dune system, Portugal (CP = Checklist parameter; S = Score value; For VI and PM see text).

CP	S	CP	S	CP	S	CP	S	CP	S
A1	2	B1	4	C1	4	D1	4	E1	2
A2	4	B2	4	C2	4	D2	4	E2	1
A3	0	B3	0	C3	2	D3	2	E3	4
A4	4	B4	4	C4	2	D4	0	E4	4
A5	0	B5	2	C5	4	D5	4	E5	4
A6	4	B6	4	C6	2	D6	4	E6	0
A7	4	B7	2	C7	2	D7	2	E7	2
A8	3	B8	4	C8	2	D8	0	E8	1
		B9	2	C9	4	D9	4	E9	0
				C10	4	D10	0	E10	4
				C11	4	D11	2	E11	4
				C12	0	D12	0		
						D13	0		
						D14	0		
Σ	21		26		34		26		26
%	65.6		72.2		70.8		46.4		59.1
Σ A to D = 107									
VI = 63.7%								PM = 59%	
VI/PM ratio = 1.08									

protection measures for the system. It should, however, not be interpreted as representing 'well-managed, under-managed and over-managed systems'. It is merely a visual representation of the actual field / management conditions at that site. Managers should refer to the details of the *checklist* when determining future management strategies. Further discussion may be found below and in Williams et al. (1993a and b), Davies et al. (1995) and Meur (1993).

The *checklist* enables spatial comparisons to be achieved, and repeated application of the procedure at specific sites would generate useful information on temporal changes. The latter in particular, enables discontinuities to be detected. This is an important management requirement since environments do not necessarily change on a regular or orderly basis. Non-linear variations are possible and monitoring through repeated application of the checklist should identify these changes. Whereas major gestalt shifts in the environment will be immediately apparent - for example foredune destruction in a major storm, and rapid strategic responses initiated, identification of subtle changes which could undermine the long-term survival of the system is a more significant management challenge.

Discussion

Three sites with varying relationships between vulnerability and managed protection measures have been selected to illustrate the concepts and approaches illustrated above (Fig. 3). The range of qualitative and quantitative parameters which have been developed via the **W**-method of problem solving, have proved to be a valid assessment of coastal dune vulnerability and management. For example:

1. Northam Burrows, N. Devon, UK. (Fig. 3) appears to be an over-managed site (VI/PM ratio 0.46, Table 1). However it must be regarded as an effectively managed system within the context of the degree of vulnerability which the checklist has identified. There is clear recognition by dune managers of the paucity of sand input from the coarse, clastic beach. The evident potential vulnerability of this system has resulted in a highly managed visitor access system with extensive fencing and controlled parking. At present the dunes show few signs of actual degradation; the conditional vulnerability is low (Fig. 2). It is a well managed system, and the methodology outlined in this paper has clearly verified this management strategy.

2. In contrast Kerlouan, located on the N Finistère coastline in France, the *checklist* technique has shown that a poor management response exists to what is a significant vulnerability threat (VI/PM ratio 2.39, Table 1). The dune ridge is narrow, wet slacks have been drained for agriculture and sand was quarried after the Second World War. Camping and housing developments are in close proximity to the system and visitor access is good with paths breaching sections of the dune front. Wave erosion and dune cliffing is occurring, especially near granite rock promontories. The response of the authrorities has been to install wind breaks, control parking and undertake some vegetation planting. Revetment work has been required to protect housing at

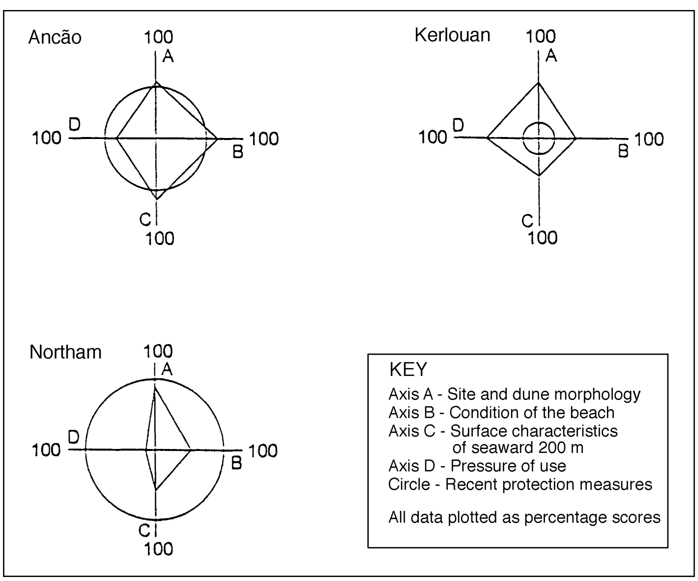

Fig. 3. Graphical representation of dune site parameters and protection measures for selected dune systems.

Kerzenval and Saint Egarec. Overall however, the management response has been low (18%) and the *checklist* has quantified the signs of system stress in spite of the good sand supply from the beach. This system can be regarded as an under-managed site within the context of the parameters identified by the *checklist* procedure.

3. Ancão is situated on a barrier island on the southern coast of Portugal. Dune erosion occasionally becomes severe due to major storm activity. However, because of its isolated location the 'Pressure of Use' parameters (Section D in the checklist, App. 1) is low, and rapid recovery of the system results from a very good sand supply, (identified in B2 of the *checklist*, App. 1 and Table 2). Management response is in equilibrium with the perceived risk (VI/PM ratio 1.08, Table 1). Therefore Ancão may be considered to be a well managed system.

Probably, there is no *checklist* with a universal application: some parameters may be inappropiate e.g the existence of wet slacks (A.7, App. 1), which are common at northern European sites but lacking in Mediterranean systems. Some may have to be included with respect to a specific context e.g. *Ammophila* (marram) has been identified as the major colonising dune species for NW European dune systems (C.8, App. 1), whereas in southern European dune systems, other *Graminae* would probably be more appropriate (Williams et al. 1994). In some locations, parameters related to Recent Protection Measures (Section E, App. 1), should be related to effectiveness rather than existence. For example, no one is allowed to wander through dune systems in Portugal, but in practise this is ignored (relevant to parameters E1, 2, 6 and 11, App. 1). In the Huelva region of Spain, managed paths (E6, App. 1) are usually narrow and ignored by the public. Experience suggests that up to 10% of the parameters may have to be modified for dune sites within specific regional contexts. There is some evidence that single parameters can dominate the behaviour of dune systems. For example an abundance of sand supply can compensate a high potential vulnerability within any individual dune complex. At Grand Cohort, France (Davies et al. 1995) control of high (4000+ per day) visitor usage has been undertaken by the Office National de la Chasse using a single access point to the system. Without the extensive sand supply this management strategy would not have enabled rapid recovery from the previous phase of degradation. Consequently a weighting system for the parameters within the *checklist* is worthy of further investigation and is a current line of research for the authors.

Conclusions

Management theory stresses the key importance of data quality for effective decision making. Formalised, structured and systematic analysis is a preferred approach. This principle has been applied in the context of dune management and resulted in the development of a *checklist* of dune parameters. The **W**-method of problem solving has proved to be a useful procedure in developing and testing the data system. Decision making should be rational and as far as possible utilise both qualitative and quantitative data. Indices of dune vulnerability and protection can be calculated. The technique has proved workable in the field and has been tested at various European coastal locations.

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Appendix 1. Coastal sand dune vulnerability checklist.

Name of system: **Location:** **Survey Date:** **Surveyor:**

	Section A - Site and dune morphology	0	1	SCORES> 2	3	4
1.	Orthogonal fetch	short [ ]		medium [ ]		long [ ]
2.	Surface area of dunes (ha)	> 500 [ ]		> 100 [ ]		< 100 [ ]
3.	Length of dune coast (km)	> 20 [ ]	> 10 [ ]	> 5 [ ]	> 1 [ ]	> 0.1 [ ]
4.	Width of dune belt (km)	> 5 [ ]	> 2 [ ]	> 1 [ ]	> 0.1 [ ]	< 0.1 [ ]
5.	Maximum height of dunes (m)	> 25 [ ]	> 10 [ ]	> 5 [ ]	> 1 [ ]	< 1 [ ]
6a.	If ridged - number of major ridges	> 10 [ ]	5-9 [ ]	3-4 [ ]	2 [ ]	1 [ ]
6b.	If plastered to slope - slope steepness	moderate [ ]		gentle [ ]		steep [ ]
6c.	If perched on cliff - cliff height (m)	< 2 [ ]		2-5 [ ]		> 5 [ ]
7.	Relative total area of wet slacks	moderate [ ]		small [ ]		none [ ]
8.	Particle size in foredunes	———	———	———	———	———
	Compare particle size with index	———	———	———	———	———
	Phi sizes	=< -1 [ ]	0 [ ]	+1 [ ]	+2 [ ]	+3 [ ]
	Total score / percentage					

Section B - Condition of the beach

1.	Width of inter-tidal zone (km)	> 0.5 [ ]	> 0.2 [ ]	> 0.1 [ ]	> 0.05 [ ]	< 0.05 [ ]
2.	Sand supply input	high [ ]		moderate [ ]		low [ ]
3.	Pebble cover as % of surface	0 [ ]	< 5 [ ]	> 5 [ ]	> 25 [ ]	> 50 [ ]
4.	% foredunes cliffed by the sea	0 [ ]	< 25 [ ]	> 25 [ ]	> 50 [ ]	> 75 [ ]
5.	Dune cliff as % dune height	0 [ ]	< 25 [ ]	> 25 [ ]	> 50 [ ]	> 75 [ ]
6.	Breaches in seaward face	none [ ]		some [ ]		many [ ]
7.	Width of breaches in seaward face	< 2 [ ]		2-10 [ ]		> 10 [ ]
8.	Seaweed on upper beach	much [ ]		some [ ]		none [ ]
9.	Colonisation by vegetation in zone between dune face and HWSM	much [ ]		some [ ]		neg [ ]
	Total score / percentage					

Section C - Surface character of seaward 200 m

1.	% system surface unvegetated	< 10 [ ]	> 10 [ ]	> 20 [ ]	> 40 [ ]	> 75 [ ]
2.	Blowouts as % of system area	< 5 [ ]	> 5 [ ]	> 10 [ ]	> 20 [ ]	> 40 [ ]
3.	Sand blown inland from system	little [ ]		some [ ]		much [ ]
4.	Saltwater invasion of dunes	none [ ]		some [ ]		much [ ]
5.	% new dunes along seaward edge	> 50 [ ]	> 25 [ ]	> 5 [ ]	< 5 [ ]	0 [ ]
6.	% breaches with new dunes	> 75 [ ]	> 50 [ ]	> 25 [ ]	> 5 [ ]	0 [ ]
7.	% seaward dune front vegetated	> 90 [ ]	> 60 [ ]	> 30 [ ]	> 10 [ ]	< 10 [ ]
8.	If recent sand deposition assess colonisation by marram	much [ ]		some [ ]	none [ ]	
9.	% impenetrable cover	some [ ]		little [ ]		none/much [ ]
10.	Frontal change since 1940	advance [ ]		oscil. [ ]		retreat [ ]
11.	Vegetation change since 1940	inc. [ ]		oscil. [ ]		decr. [ ]
12.	Relic quarries in frontal (200m)	none [ ]		small [ ]		large [ ]
	Total score / percentage					

Section D - Pressure of use

1.	Visitor pressure	low [ ]		moderate [ ]		high [ ]
2.	Road access	none [ ]		moderate [ ]		good [ ]
3.	On-dune driving	none [ ]		some [ ]		much [ ]
4.	Horse riding	none [ ]		some [ ]		much [ ]
5.	Path network density	low [ ]		medium [ ]		high [ ]
6.	Paths incised	little [ ]		moderate [ ]		deep [ ]

App. 1; Section D, cont.		SCORES> 0	1	2	3	4
7.	Commercial camping	little [ ]		some [ ]		much [ ]
8.	Dispersed camping	little [ ]		some [ ]		much [ ]
9.	Housing	little [ ]		some [ ]		much [ ]
10.	Owners	one [ ]		some [ ]		many [ ]
11.	Main owner/manager	protection agencies [ ]		public [ ]		priv. [ ]
12.	Commercial/random extraction	none [ ]		some [ ]		much [ ]
13.	Grazing by cattle/sheep/goats	none [ ]		some [ ]		much [ ]
14.	Rabbit population	small [ ]		moderate [ ]		large [ ]
	Total score/percentage					
	Vulnerability score and index					

Section E - Recent protection measures

		0	1	2	3	4
1.	Surveillance and maintenance	none [ ]		some [ ]		much [ ]
2.	% area with restricted access	0 [ ]	< 10 [ ]	> 10 [ ]	> 25 [ ]	> 50 [ ]
3.	Controlled parking	none [ ]		some [ ]		all [ ]
4.	Horse riding controlled	none [ ]		some [ ]		all [ ]
5.	On-dune driving controlled	none [ ]		some [ ]		all [ ]
6.	Managed paths	none [ ]		some [ ]		all [ ]
7.	Sand traps	few [ ]		some [ ]		many [ ]
8.	Planting on mobile areas (%)	0 [ ]	< 10 [ ]	> 10 [ ]	> 25 [ ]	> 50 [ ]
9.	Information boards	none [ ]		some [ ]		many [ ]
10.	If marine erosion - protection work?	neg. [ ]		some [ ]		much [ ]
11.	Protection by legislation	weak [ ]		moderate [ ]		str. [ ]