Concepts and Science for Coastal Erosion Management

CONSCIENCE

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Description of coastal state indicators

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1 Description

The definition implicitly assumed by COASTVIEW for Coastal State Indicators (CSI's) was - *a reduced set of parameters* (the sign or signs) *that can simply, adequately and quantitatively describe the dynamic-state and evolutionary trends of a coastal system* (relay a complex message in a simple and useful manner) (Jiménez and van Koningsveld (COASTVIEW CSI report Nov '02), 2002).

CSI's major functions are:

- to assess the condition of the environment
- to monitor trends in conditions over time
- to compare across situations
- to provide an early warning signal of changes in the environment
- to diagnose the cause of an environmental problem
- to anticipate future conditions and trends

2 Criteria

Following previous works in the development of environmental indicators (e.g. Kelly and Harwell, 1990; Cairns et al., 1993; Pykh et al., 1999; Jackson et al., 2000; Dale et al., 2001), it is possible to identify some basic criteria that CSI's must fulfill to be useful and consistent.

• ***Be relevant***
It must be demonstrated that the proposed indicator is conceptually linked to the coastal function of concern. This link has to be of "first-order", i.e. it is not only a matter that a variable takes part in the process but that it is significantly contributing to it. This requires a scale analysis, in which key variables/processes/responses are selected according to the significance of their role in the coastal function at the proper scale.

• ***Be easily measured***
The indicator should be straightforward and relatively inexpensive to be measured. This also includes requirements such as meeting data quality objectives (whatever they are) and being consistent with the process/variable of interest, e.g. it makes no sense to determine beach width with a precision of mm, since this precision does not imply a better characterization of the system response.\

• ***Be sensitive to stresses on the system***
The indicator should be responsive to stresses on the system. Applied to ecological indicators, the ideal situation would be an indicator that is sensitive to stresses due to human actions while having limited and documented sensitivity to natural variation (Dale and Beyeler, 2001). When this is applied to CSI's, it has a series of implications. Thus, one of the intrinsic characteristics of the coastal zone (and for any environmental issue in

general) is that it is a highly dynamic system, and, in consequence, it will be necessary to "live" with it, i.e. any selected indicator will have a "natural-induced" source of variation and a "human-induced" one. The key point will be the identification and isolation of each component from gathered data.

• ***Have a known response to disturbances, anthropogenic stresses, and changes over time***
The indicator should have a well-documented reaction to both natural disturbance and to anthropogenic stresses on the system. This means that any variable or characteristic of the system can only be used as an indicator provided that there is a scientifically sound pattern of response. In other words, to simplify a system we need to know which are the elements of the system and how do these react to stress.

• ***Be anticipatory***
A change in the indicator should be measurable before substantial change in the targeted objective occurs. This implies the selection or definition of a threshold which serves as a "warning signal" to indicate the changes.

• ***Be integrative***
The full suite of indicators provides a measure of the key gradients across the analyzed system (change in the system state in time and space). Moreover, it must be possible to aggregate in order to generate an issue-oriented indicator. In coastal issues, this is not only a criterion to be fulfilled by indicators but the common way of approaching coastal processes. Thus, the issue of temporal and spatial integration of coastal processes and responses has been largely identified as a key task in analyzing coastal dynamics at scales useful for coastal management purposes (e.g. de Vriend, 1991; de Vriend et al., 1994).

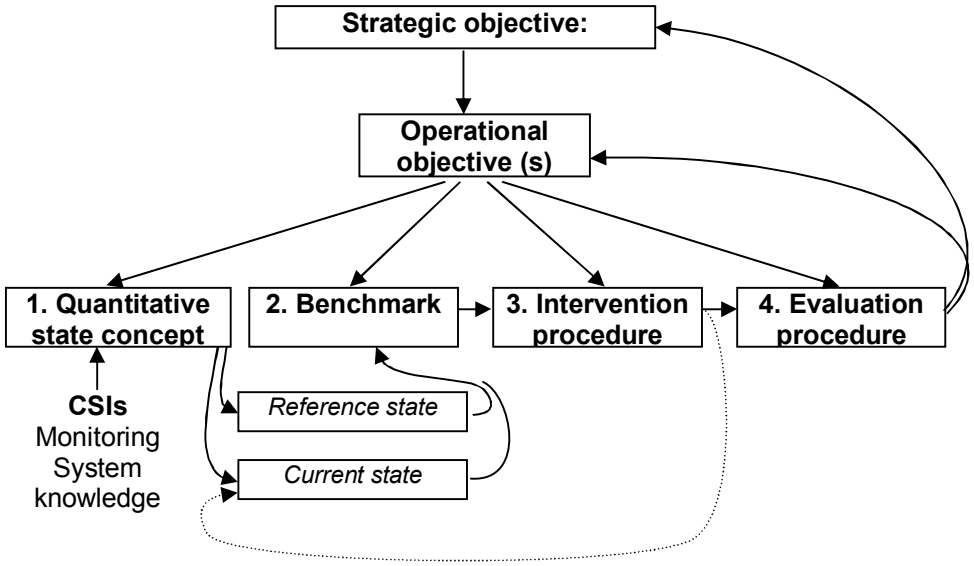
• ***Other criteria***
In addition to the above cited basic criteria, we can find additional ones that have been imposed in different approaches such as:
a. Be user-driven
b. Be simple and easily understood by the target audience
c. Be scientifically credible
d. Be responsive to changes in time and space

It is vital that determination of appropriate CSI's receives input from two groups, from the managers and policy makers, and from the scientists. The former are able to assess what information will be of most value to the manager, while the latter can determine what might be possible based on existing or potential technology and scientific understanding.

3 Development

Van Koningsveld (2003) presented a clear process (*'frame of reference'*) that permits the resulting CSI's to assist in decision making by associating them with strategic management objectives, setting benchmarks beyond which

action is required, and providing an assessment stage which appraised the result of the action taken. This process is described in the figure below:



The frame of reference postulated by Van Koningsveld (2003) involves the following key elements:

- A **strategic objective**: that expresses the long-term management vision and policy.
- An **operational objective**: that describes how the strategic objective will be achieved in a four stage process:
  1. *Quantitative state concept*: a means of quantifying the problem in hand. The application of CSI's is relevant at this stage of the process.
  2. *Benchmarking process*: a means of assessing whether or not action is required. At this stage CSI's are compared to a threshold value.
  3. *Intervention procedure*: Defines in detail what action is required if the benchmark values are exceeded.
  4. *Evaluation procedure*: Assesses the impact of the action taken. If the action has not been successful it may be necessary to revise the strategic/operational objectives and hence the feedback loops indicated in the Figure above.

There are several important advantages gained through invoking the *frame of reference* approach:

- The frame of reference procedure facilitates clear, unambiguous communication between coastal scientists and managers.
- The CSI's are clearly linked to the overarching strategic objective and therefore the relevance of the indicator is clear to the coastal manager.
- The CSI is clearly embedded within a broader framework that has a well defined response and assessment procedure.
- The framework ensures a rigorous definition of CSI's, the required accuracy and the associated benchmark values.

4 Available Coastal State Indicators

Some currently utilized CSI's include (Van Koningsveld and Lescinski, 2007):

1. Total Beach Volume
2. Total Profile Volume
3. Beach Width
4. Shoreline Position (MCL)
5. Dune Volume
6. Dune Erosion Point
7. Dune Foot Location
8. Mean High Water
9. Mean Low Water
10. Beach Slope
11. Berm Level
12. Berm Width
13. Run-up Level
14. Dune Crest Height
15. Dune Width

5 Conscience field sites

5.1 Coastal State Indicators:

	Lloret de Mar & s'Abanell beaches	Inch Beach	Danube Mouth	Hell Peninsula	Pevensey Bay Barrier	North Holland Coast
Shoreline position	yes threshold not yet established;	not available threshold not yet established	yes threshold not yet established	yes threshold not yet established	yes threshold not yet established	yes; threshold available
Dune toe	no dunes	yes; threshold not yet established	yes threshold not yet established	data available	Not applicable	yes; threshold available
Beach width and slope between upper and lower boundaries	yes threshold not yet established;	not available	yes threshold not yet established	yes threshold not yet established	yes threshold not yet established	yes threshold not yet established
Beach volume between upper and lower boundaries	data available	no data available	data available	data available	yes threshold not yet established	yes threshold not yet established
Berm level and berm width	no berms	no berms	no berms	no berms	data available	no berms
Dune volume	no dunes	no data available	data available	data available	no dunes	yes thresholds available
Dune crest height and width above datum	no dunes	no data available	data available	data available	no dunes	yes thresholds available
Run-up level (level exceeded by 2% of the swash)	no data available	no data available	no data available	no data available	no data available	no data available

Shingle ridge crest height and width.	not applicable	not applicable	not applicable	not applicable	data available	not applicable

5.2 Available Data:

	Lloret de Mar & s'Abanell beaches	**Inch Beach**	**Danube Mouth**	**Hell Peninsula**	**Pevensey Bay Barrier**	**North Holland Coast**
Sediment composition		yes	yes	yes	yes	yes
Bathymetry (area):	yes	yes; historical charts	yes	yes	yes (incl. aerial photos)	yes
highest/lowest contour to datum:	down to 50 m		1.5 m depth lowest 10 m depth	down to 10 m depth	down to 20 m depth	up to dune crest
Wave climate	Directional wave climate from Nearshore (50 m deep) wave buoy	Data available f	Simulated data based on wind records	directional wave data	directional wave data	directional wave data at various stations
Wind climate	yes	yes, based on local airport database	yes	yes	yes	yes
Tidal climate	yes	no local data	no	yes	no local data	yes
Longshore currents	no	no	no	no	no	yes, at various locations
cross-shore currents	no	no	no	no	no	yes, at various locations
Recirculating curents (yes/no)	no	no	no	no	no	yes, at various locations

5.3 Gaps in Data:

	Lloret de Mar & s'Abanell beaches	**Inch Beach**	**Danube Mouth**	**Hell Peninsula**	**Pevensey Bay Barrier**	**North Holland Coast**
Sediment composition	no	yes	yes	if, required	no	no
Bathymetry	no	if, required	yes	no	no	yes (regular programme)
Shoreline position	yes	yes	yes	no	no	yes (regular programme)
Dune toe position	no	yes	Yes	no	no	yes (regular programme)
Wave climate	yes	yes	no	yes	no	yes (regular programme)
Wind climate	no	yes	yes	no	no	yes (regular programme)
Tidal climate	yes	no	no	no	no	yes (regular programme)
Longshore currents	no	no	yes	no	no	no
cross-shore currents	no	no	yes (if possible)	no	no	no