Remote Sensing Applications Requiring Research

Table 14 lists the ecosystem health indicators that were considered to be "feasible" for using remote sensing to map and monitor. There were a number of criteria used to assign each indicator to the feasible class, some of which can be addressed by further research and other by technological and technical advances.

The principal limitation restricting operational monitoring of a number ecosystem health indicators concerns the use of hyperspectral image data. A large number of water quality (TSM/Tripton, Chla and CDOM), water depth and submerged aquatic vegetation (type and biomass)parameters are only able to be mapped by using hyperspectral image data and image processing algorithms designed to work with hyperspectral data. Currently, airborne hyperspectral data (e.g. CASI and Hymap) is prohibitively expensive to fly on a regular basis for monitoring coastal environments, while satellite hyperspectral adta is restricted to experimental sensors (e.g.Hyperion with 30m pixels, 7km swath) and MERIS-MODIS sensor data with > 250m pixels.

Water quality parameters, submerged aquatic vegetation species and biomass, and the amount of live/dead coral cover are able to be accurately and repeatedly mapped from hyperspectral image data sets (Mumby et al., 1997; Lee et al., 1999; Green et al., 2000; Dekker et al., 2001; Dekker et al., 2001; Brando and Dekker 2003; Goodman and Ustin 2003; Joyce et al., 2003; Malthus 2003). However, the development, testing and validation of these applications has been conducted over small areas using airborne or experimental satellite hyperspectral data that could not be repeated over a large area on a regular basis in a cost-effective manner for monitoring. These data sets are not suited for monitoring coastal environments as their spatial resolution is either too fine (< 5m) or too coarse (< 250m), and the area they cover is too small (e.g. Hyperion's 7km wide swath). If a hyperspectral sensor were to be launched with 10m – 30m pixels and a 200km swath, providing image data on a regular basis at a reasonable price, it would take most of these applications to an operational level as suitable processing algorithms already exist. There are plans to launch such satellites, including, Digital Globe's Worldview by 2008. Until these sensors are launched, hyperspectral data for coastal monitoring will retain its focus on relatively small areas.

Two other types of applications remain, those that are not feasible at all and those where it is still unknown if remote sensing can be used for mapping the target of interest. The non-feasible applications are not defined specifically as indicators that cannot be measured, but indicators in zones of certain water clarity or depth where optical remote sensing will not function. This includes areas that are too turbid or deep for a single from the substrate to be received. In these cases it is recommended that an active form of mapping such as acoustic or side-scan sonars is used. Another non-feasible case is where the target(s) to be mapped cannot be separated, e.g. seagrass species or level of Chlorophyll. This type of limitation is not particularly well documented and it is recommended that any study trying to discriminate features checks past work and models to ensure their targets will be recognised.

The final applications, those where we do not know if remote sensing can be used to map an indicator of interest, are limited to sparse inter-tidal seagrass in highly turbid waters and coral condition and composition. These topics form the basis of current research of the authors and several others using extensive field survey and image data sets.

Table 14: Coastal ecosystem indicators for use with remotely sensed data requiring further research . Modified from Phinn et al. (2005), Roelfsema and Phinn (2004)

Coastal ecosystem health indicator	**Can remote sensing be used?**	**Environmental constraints on application (e.g depth, clarity)**	**Sensor and Location of previous work**
Terrestrial vegetation -Structure	Feasible	Topographic effects	Landsat TM/ETM SPOT Ikonos/Quickbird Radarsat Stereo - Aerial photography
Water Quality - Concentrations TSM/Tripton Chla CDOM	Operational only in coastal waters to a limited extent Feasible Feasible Feasible (clear/turbid)	Inherent optical properties Depth Water clarity	MODIS MERIS Hyperion Landsat TM/ETM CASI/Hymap
Toxic chemical spills	Feasible	Ocean surface roughness	Hyperion CASI/Hymap
Substrate type Rock platforms	Feasible (exposed areas, clear and optically shallow water)		Hyperion Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
SAV type	Feasible (clear and optically shallow water)	Inherent optical properties Depth Water clarity	Hyperion Landsat TM/ETM SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
SAV Biomass	Feasible (clear and optically shallow water)	Inherent optical properties Depth Water clarity	SPOT Ikonos/Quickbird CASI/Hymap Aerial photography Side-scan sonar
Coral Live/Dead	Feasible (clear and optically shallow water)	Inherent optical properties Depth Water clarity	MERIS Hyperion Ikonos/Quickbird CASI/Hymap Aerial photography