What is remote sensing and what type of information can it provide for coastal environments (in comparison to field data)?

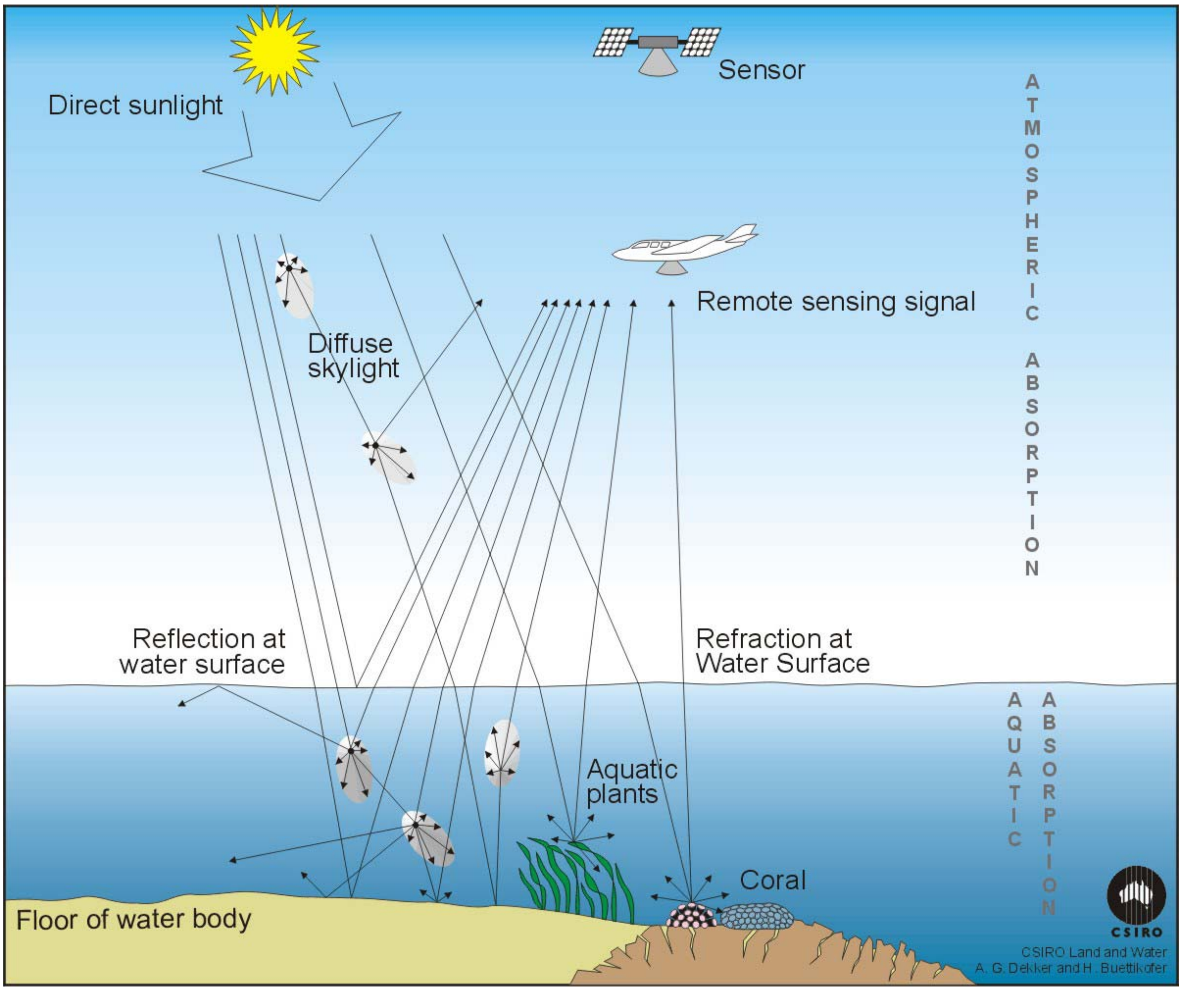
Remote sensing is any form of measurement where the measurement device is not in direct contact with the target. For example, the temperature of a water body can be measure directly by placing a thermal data logger in the water or indirectly using a satellite sensor that measures the temperature of the earth' surface.

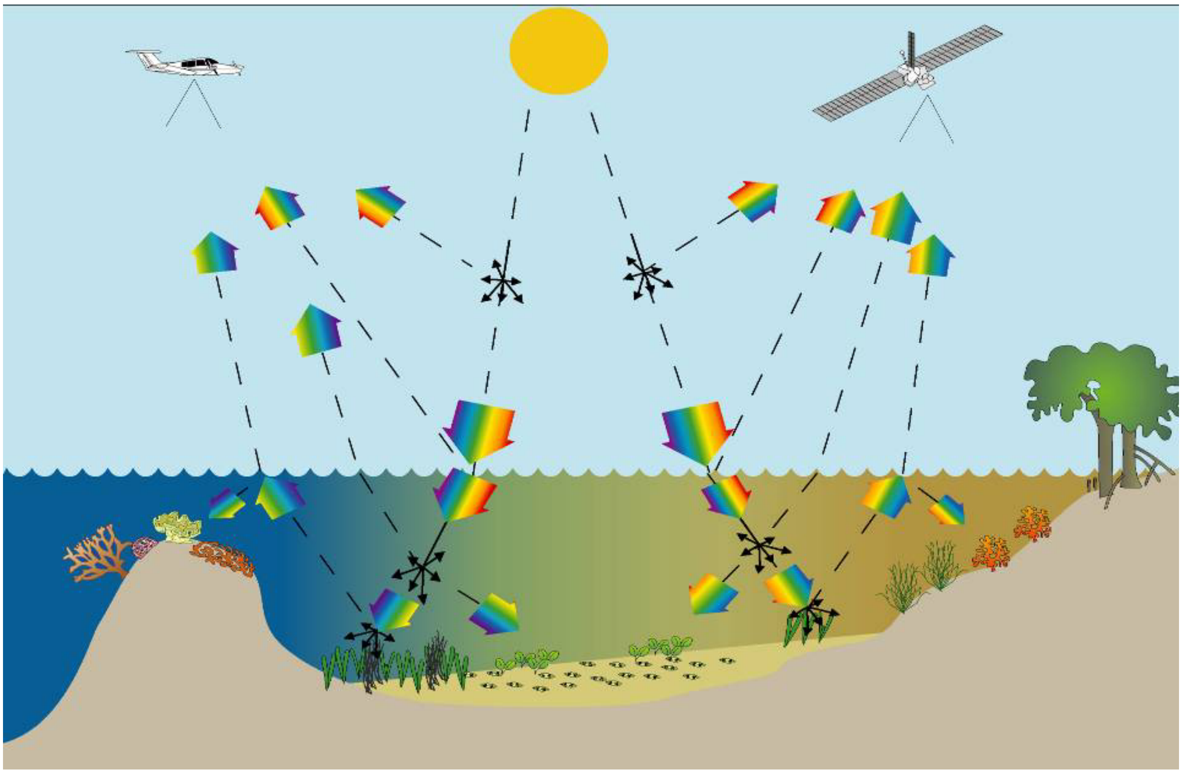
In coastal environments remote sensing techniques are usually applied to map: water depth; the concentration of materials in the water column (e.g. chlorophyll and suspended sediments); and the type of material present on the substrate (e.g. seagrass) and is structural and/or physiological properties (e.g. seagrass density or biomass). A range of remote sensing data types can be used in coastal environments, including passive instruments which rely on reflected sunlight and active systems, such as sonar, which generate their own source of illumination.

Images recorded by passive systems contain a record of how sunlight in specific wavelength regions of colours is absorbed and scattered by the water column and benthic substrate. Understanding and processing images of the coastal environment requires an understanding of all the interactions presented in Figure 1.

This toolkit focuses mainly on passive systems and describes their use for a range of coastal mapping applications in a range of environments, in terms of depth and water clarity gradients (Figure 1).

Figure 1: Conceptual models of the physical processes involved in the Remote Sensing process , identifying all of the controls on light interactions that are recorded in images (top diagram) and the differences in light interactions in clear and turbid waters (lower diagram).





The operation of remote sensing in a coastal environment is best explained with an example. Figure 2 shows an example of what an image looks like on the ground and what it looks like in images with different spatial and spectral resolutions. The far left pictures show the three main types of seagrass present in the imaged area. The middle image is a 2.4m pixel Quickbird image and the end image is a 30m pixel Landsat TM image. The image-maps below each image show the type of mapping zonation possible from each image data set.

The following terms are used to differentiate between the range of commercially available image data sets. Each term or resolution attribute determines how much and what type of information can be extracted from an image of the coastal environment. How remote sensing images are acquired, covering image dimensions (spatial, spectral, temporal), information extraction processes and coastal environment factors that affect remote sensing.

SPATIAL RESOLUTION
- This refers to the width and area covered by the full image (e.g. 10km x 10km) and the pixel size, e.g. 2.4m and 30m in the Quickbird and Landsat images below.
- This affects the level of detail and size of features able to be mapped.

TYPE OF INFORMATION
-Images can either be from passive or optical sensors. Passive systems measure reflected sunlight and cannot operate through smoke or cloud or at night. These systems cannot provide substrate information in optically deep water, due to depth or clarity. Active systems illuminate the target with their own source of energy and measure the response, this includes acoustic, imaging radar and airborne laser systems.
-An additional control on the type of information measured is the number and placement of spectral bands, which are the regions in which reflected or emitted light are measured. Multispectral systems emasure fewer than 10 bands and hyperspectral systems cover > 10 bands.

FREQUENCY OF IMAGE ACQUISITION
- Images are acquired by sensors on satellites which are typically in polar orbit with a regular revisit time, that is they collect an image over a set location at the same time at a regular repeat cycle. For some sensors, often with pixels > 250m, this is a daily repeat. For other sensors it may vary from 4-16 days and may be less if the sensor has pointable optics.

TRANSFORMING IMAGES TO MAPS OF ENVIRONMENTAL FEATURES OR PROCESSES
- Once an image for a coastal environment has been acquired it is then subject to a sequence of image processing operations to allow it to be integrated with other spatial data and to represent a thematic (Figure 2) or continuous map of the variable of interest. A number of approaches are available to conduct this type of processing and to deliver useful maps.

COASTAL ENVIRONMENT FEATURES THAT RESTRICT THE USE OF REMOTE SENSING SUBSTRATE AND WATER QUALITY MAPPING

Mapping of coastal features from image data sets is complicated by the following factors:

- water clarity:	increased water clarity increase the ability to map substrate features but decrease the ability to map water quality features
- water depth:	increases water depth decreased the ability to map substrate features but increase the ability to map water quality features
- water roughness:	increases water roughness reduces the ability to map substrate features
- cloud cover:	unable to correct for
- cloud shade:	reduce the quality but can correct for
- smoke:	difficult to correct for depending on the thickness

Figure 2: The view on the ground to the view from space – a sequence of images showing the how different substrate cover types appear on the ground and their representation within satellite images acquired using 2.4m and 30m pixels. NOTE – ARROWS NEED TO BE CORRECTED