Environmental descriptors

DEFINITION

Variables that can be used to describe the environment.

DESCRIPTION

Environmental descriptors are variables that can be used to describe the environment. The spatial distribution of species (including biogenic habitats) is influenced by the environment surrounding them. In most cases, the environment can be described using climate variables, such as temperature or precipitation. These variables influence where species can live and reproduce (based on their physiological tolerances) and are therefore informative in predicting or explaining species' distributions. The distribution of species is also influenced by a range of non-climatic variables, such as elevation (terrestrial biomes), depth (marine biomes), or chemical variables such as salinity.

In addition to the above factors, the availability of resources (e.g. nutrients, foraging material, breeding habitat) also play an important role in explaining species distributions, due to their influence on the growth and reproductive capacity of species. For example, warming sea temperatures have been observed [1] and are predicted to lead to poleward shifts in species' distributions. However, the persistence of these species in a new area will also depend on their ability to find

food and breed [2], [3].

COVERAGE

Environmental descriptors may be provided at regional or global scales, and their resolution will vary depending on the source of the data, number and resolution of observations made, or the type of mathematical model or algorithm that has been used to create them. Most descriptors change over time as environmental conditions fluctuate. Therefore, descriptors should be used with reference to a given time frame. They are often averaged over specified time periods to account for inter-annual variability, for example as global annual means or regional monthly means.

Although environmental data may be obtained across multiple spatial scales, data at a fine ($\leq$1 km^2) spatial resolution is frequently necessary to capture environmental variability. This is particularly the case in areas with a steep topography or slope, as well as in areas with frequent seasonal fluctuations. Interpolation and modelling may therefore be required to obtain a full dataset of an environmental descriptor.

EXAMPLES OF ENVIRONMENTAL DESCRIPTORS

TERRESTRIAL BIOS

Common environmental descriptors for the terrestrial biosphere relate to climate, water quality and soil conditions, as these are major influencers of vegetation growth and biodiversity.

1. CLIMATE DESCRIPTORS

Climatic descriptors include all environmental variables that change according to weather conditions, such as air temperature, precipitation and humidity. Climatic variables are one of the main controls on the distribution of biomes, as different types of organisms have different optimal climatic ranges within which they thrive best. Climatic data is available from national meteorological stations across the world which collect daily (or more frequent) weather measurements. Climate records can also be extended into the geological past by using proxy data such as ice cores, tree rings and stratified sediments, or projected into the future by predictive modelling.

An array of data on climatic descriptors for the terrestrial and marine environments can be accessed through the Copernicus Programme[4], for instance. This dataset includes global and regional datasets of mean annual sea surface or air temperature, precipitation, and other environmental descriptors relating to climate.

2. SOIL DESCRIPTORS

Soil is a crucial feature of crop production. The 'health' of soil and its characteristics that affect vegetation growth can be measured and used in agricultural management, or to understand natural vegetation patterns across the world. For instance, the Harmonised World Soil Database[5] contains global maps of selected soil parameters which are relevant to agriculture. This includes nutrient availability, nutrient retention capacity, rooting conditions, oxygen availability to roots, excess salts, toxicities and workability. Soil descriptors are also useful in explaining the nitrogen and phosphorus nutrient cycles which underpin most ecosystem processes (e.g. plant growth and decomposition). They can also be a useful tool in monitoring pollution, as excess levels of organic chemicals in soils are often an indication of agricultural or industrial pollutants.

3. WATER QUALITY INDEX (WQI)

The Water Quality Index (WQI) uses data on water temperature, dissolved oxygen, pH, salinity and chemistry to derive a composite index of water quality. It has been developed by United Nations Environment's Global Environment Monitoring System (GEMS) Water Programme, and can be used on a global scale as data are available for most countries of the world. The WQI is used to assess the overall quality of inland surface water resources, given the importance of clean freshwater for biodiversity and for human health.

M A R I N E B I O S P H E R E

1. SEA SURFACE TEMPERATURE

Sea surface temperature is a main control on the distribution and abundance of marine biodiversity, as the majority of organisms respond to the temperature of their immediate environment. This makes sea surface temperature a useful environmental descriptor for several organisms. Sea surface temperature is a climatic descriptor which is controlled by other climatic variables such as air temperature, ocean currents and wind systems. Marine species in groups as diverse as mammals, fish and invertebrates show strong phenological responses to seasonal temperature changes. For example, warm-water corals have a symbiotic

relationship with photosynthetic algae called zooxanthellae, which live in coral tissue and provide corals with nutrients. Small increases in the mean sea surface temperature can cause acute temperature stress on corals, which causes them to expulse zooxanthellae from their tissue [6].This phenomenon, known as coral bleaching, is one of the major concerns for coral reefs in light of climate change.

Existing data on sea surface temperature and other marine environmental descriptors and information on where to find them are described in the Manual of marine and coastal datasets of biodiversity importance [7] and Ocean+ Data.

2. SEA SURFACE PRODUCTIVITY

The concentration of chlorophyll a pigments (the photosynthetic pigments of phytoplankton) is often considered as an index of biological productivity. In oceanic environments, it has been widely related to the distribution and abundance of a range of marine species, including fish and mammals. The availability of global, daily, systematic and high-resolution images obtained from satellites has been a major data source for estimating global sea surface chlorophyll a concentrations. This information can be expressed as global annual averages which are used to capture spatial variation in productivity. An example of this variation would be between highly productive upwelling regions and nutrient poor tropical waters. Mean global chlorophyll a at the sea surface is dominated by the unicellular phytoplankton, which are microscopic photosynthesising organisms that are abundant in the upper oceanic layers. Other important primary producers in the ocean surface are photosynthetic bacteria, macroalgae such as kelps and marine plants such as seagrasses [8].

Mean sea surface productivity is a useful environmental descriptor because many organisms feed on primary producers in the surface waters, including invertebrates and fish. In turn, this attracts larger marine animals such as whales, dolphins and sharks which often migrate vast distances to reach the most productive surface waters [9]. Any changes in the location, duration and extent of highly productive surface waters is therefore expected to cause matching changes in the distribution, abundance and migration patterns of these organisms.

EXAMPLES OF USE

Some environmental descriptors can be used as indicators of biodiversity and ecosystem health, based on the known effect that some environmental variables have on species or habitats.

For instance, the Biodiversity Indicators Partnership (BIP) is a global collaboration by expert organizations, led by the Convention on Biological Diversity (CBD), which has developed a set of biodiversity indicators to be used at a global scale. The aim is to establish a set of indicators which can comprehensively describe trends in biodiversity, and which would help to track any improvements toward meeting the Aichi Targets. Several environmental descriptors are used as biodiversity indicators, such as nitrogen deposition (as a proxy of pollution) and the Water Quality Index described above.

The Marine Strategy Framework Directive (MSFD) [10] is the first EU legislative instrument related to the protection of marine biodiversity. Its overall aim is to promote sustainable use of the European seas and to conserve marine ecosystems, by implementing measures to reach Good Environmental Status (GES) in Europe's seas by 2020. The MSFD defines 'good environmental status' as:

"*the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive*".

To help Member States interpret what GES means in practice, the MSFD also sets out 11 environmental descriptors which describe what the seas would look like when GES has been achieved. Some of these descriptors, such as 'Eutrophication is minimized' and 'Concentrations of contaminants give no effects', are based on environmental descriptors. As these are broad descriptors, each one has a set of detailed criteria, indicators and targets to help its implementation [10].

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Tools

Ocean Data Viewer A tool for easy access to a range of datasets that are important for the conservation of marine and coastal biodiversity. The data can be downloaded or viewed online.

Ocean+ Data A tool that provides an overview of a range of global marine and coastal datasets of biodiversity importance. The site allows users to filter by category, organisation and theme.

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