The Queensland Litter and Illegal Dumping Management Framework

Attribute-based Litter Classification Scheme

#32184 | 1220

Queensland Government

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Published by the Queensland Government, 2020.

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Citation

Department of Environment and Science 2020, Queensland Litter and Illegal Dumping Management Framework, Attribute-based Litter Classification Scheme.

Acknowledgements

Maria Zann, Kylie McPherson, Lana Baskerville, Denise Hardesty, Brad Dalrymple, Paul Dubowski, Heidi Taylor, Leigh Bennett, Ian Cameron, Jenny Daly, Robert Ferguson, Peter Noonan, Paulina Kaniewska, Leigh Bennett, Stacey Maddock-Armstrong, Ian Heiner, Gina Cavendish, Julie Hoek, Michael Leja, Chris Norman, Dane Moulton.

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Summary

A coordinated approach is required between the Queensland Government, local government, community clean-up groups and other key stakeholders to manage data relating to littered and illegally dumped waste and identify opportunities to reduce it.

The Queensland Government developed the Litter and Illegal Dumping Management Framework (LIDMF) to provide a structured framework for understanding how littered and illegally dumped solid wastes move from original sources, through pathways to sinks (places it ends up), and consider the effects on a range of values.

The LIDMF is underpinned by an Attribute-based Classification Scheme (the Scheme) that allows items of waste in the environment (e.g. plastic bottles and cigarette butts) to be reduced into their component parts.

Understanding these basic components, and how waste is made up of these basic parts, allows for more accurate reporting—different materials and their eventual impact on human health, wildlife and the environment, irrespective of their degree of intactness. This information can be used to identify gaps, monitor wastes in the environment and apply management interventions where most effective.

The Scheme was developed through a process involving documentation of relevant research guiding classification, workshop consultation incorporating participant feedback, fostering continuous improvement of elements of the Scheme during typology and mapping applications and confidence specifications. This document outlines the development of the Scheme.

Introduction

The LIDMF was developed to address the effects of littered and illegally dumped wastes across Queensland.

The *Waste Reduction and Recycling Act 2011* provides the overarching framework and provision for the management of, and penalties relating to, littering and illegal dumping in Queensland.

Queensland's Waste Management and Resource Recovery Strategy (the strategy) provides the strategic framework for Queensland to become a zero-waste society, where waste is avoided, reused and recycled to the greatest extent possible.

One of the key priorities of the strategy is the development of a litter and illegal dumping plan (the plan), which will outline how all Queenslanders can work together to combat litter and illegal dumping across the state.

The LIDMF will support the aims and goals of the plan and assist in guiding priority actions.

The Attribute-based Classification Scheme

An attribute-based process allows for the translation of various collected waste datasets into a common language, and:

- provides a common language for those interested in movement and pathways of waste pollution in the environment
- creates a scientific platform for discussion relating to waste pollution that hasn't been available previously
- collects data in a way that can be adapted to different management requirements
- identifies knowledge gaps and provides data for discussions with research groups
- uses an approach that is consistent, measurable, transparent, repeatable and flexible, and
- provides a consistent platform for policy and planning decisions.

By separating waste into its component parts, it can be tracked as it fragments and moves through the environment—from original sources, through pathways to sinks (where it ends up), through to effects on values. Combining attributes such as size and length with spatial attributes such as wind velocity, allows users to gain a better insight into the pathways of these wastes as they travel to reach their final sink (the place they settle).

Scope and features of the scheme

A large amount of waste travels through the environment, often breaking up into smaller pieces and ending up in our oceans. It is estimated that approximately 80% of this has come from land-based sources (Sherrington, 2016).

Although a great deal of work has been done on the effects of these wastes on wildlife such as turtles, birds and fish, there is limited ability to transparently describe wastes from its release into the environment, along the pathway it travels, to the place where it finally rests.

Neither has a comprehensive evaluation been undertaken of the full damage that occurs, both along the pathway and at the final destination.

It was determined that an attribute-based classification scheme was the most effective way to break litter and illegally dumped waste into manageable parts, which could be objectively described, irrespective of how degraded it may be. This allows these wastes to be described in its initial form (e.g. a plastic bottle) but also allows the product to be tracked as it becomes fragmented (e.g. micro or nanoplastic).

Why an attribute-based classification scheme is required

Waste pollution is avoidable, however, each year it costs the Queensland economy millions of dollars to manage. This includes clean-up costs from streets and shopping centres as well as retrieval and removal of large, dumped items.

Although the polluted locations may have been cleaned, residual damage can remain. For example, when materials such as mattresses and plastic are dumped on land or in the water, toxins can leach out and pollute the surrounding area.

This type of waste pollution can have extreme and detrimental effects on wildlife. The Currumbin Wildlife Hospital and many other organisations continually care for injured wildlife that are victims of these wastes, e.g. fishing nets, hooks and fishing-line. There are many sources of waste pollution, many paths it can travel and many effects it can have, including to human health, tourism and even property prices.

Purpose of the scheme

The LIDMF was developed to address these issues and compile all sources, pathways, sinks (where it ends up) and effects on values in one place. The main aim of the LIDMF is to have a 'whole of catchment' view of waste pollution in Queensland in order to not only provide suggestions for efficient and effective management interventions but also to predict where waste pollutants may end up following extreme weather events.

To identify and prioritise management interventions, an overview of where these wastes are having the greatest impact, and their origins are required. Having an attribute-based classification scheme at the heart of the LIDMF provides a common language to assist with communication and reduce the complexity for technical and non-technical audiences.

Currently, litter clean-up collection sheets list waste by the item type (e.g. tissue, nappy, bottle etc.). By adding a few additional attributes, the data can be separated in different ways, depending on the output required. For example, a plastic bottle when degraded can still be described by its attributes such as carbon-based, 2-10cm long, sharp etc.

By creating an attribute-based classification scheme, subjectivity is removed, and a more objective approach is applied. For example, if a bird is attracted to green plastic bags, it is going to be attracted, not specifically to the plastic bag, but to the attributes, being colour, flexibility, elasticity etc.

Attributes include measurable components of the environment that can be physical (e.g. colour, length), chemical (e.g. toxic), or biotic (e.g. biosecurity). To organise and more broadly describe attributes, they are grouped into attribute themes. In this instance two themes were chosen, characteristics and impact on values.

The range of categories within an attribute must provide for the complete domain of the attribute and should be mutually exclusive and not overlap. That is, a category must be available for any observed value (even if this is a category of 'unknown').

Metrics

Metrics (how to measure a category) can be continuous or categorical, qualitative or quantitative and are often informed by biological processes. In the case of continuous metrics, the categories for a metric may be determined by applying thresholds.

Where a category is made up of several parts, this can be dealt with through the use of descriptors, such as "contains" or through concatenation (i.e. joining with a separator "/" or "|"). For example, construction material may be made up of a mixture of characteristic categories. Using concatenation, this becomes "carbon based | corrosive", or in a type descriptor, "contains carbon and/or corrosive material". For categorical metrics the values may be directly transferred to the appropriate categories or may be reclassified into relevant categories for the attribute.

Based on available date, an attribute may utilise different metrics, provided it can be classified into the attribute categories in a consistent and comparable manner. However, the assumptions and surrogate data used to derive the attributes and categories and the degree of confidence in these should be clearly documented.

Much of this scheme is based on the attribute classification for the intertidal and subtidal habitat classification scheme undertaken by the Wetland Program. Some of the attributes will be inherently clear, while others will require additional data to be collected with the item. In this way, intact items that have changed since being deposited (e.g. through weathering or animals tearing them apart), can still be described and the information captured.

A Translational tool–Converting items into attributes

Littered and illegally dumped waste is traditionally collected using descriptions of the waste item type, such as plastic bottle, glass bottle, aerosol can etc.

Initially, existing data from sources such as the Litter and Illegal Dumping Online Reporting System (LIDORS) will separate items into their constituent attributes. A Power BI analysis tool will then be developed to ensure that queries using attributes can answer the types of questions answers are required for. In the future, a collection sheet will be developed that allows waste collected to be both collected as items and as attributes. A small amount of extra recording will be required to collect additional attribute data, although collection purely by attributes will be available if the object isn't recognisable.

Spatial attributes are also required in the scheme, along with demographic information relating to the size of the nearest towns, proximity to water and weather conditions to fully develop a 'whole of catchment' overview and identify environmental variables.

Methodology

The following section provides details on the key principles and concepts that underpin the scheme and how these address issues raised during collaboration and consultation.

Principles

The overarching principles include:

- an attribute-based classification scheme providing a core knowledge base, enabling data collected by one group to be effectively used by others
- provides a distinction between attribute classification and typology
- provides a purpose for attribute classification and the typology
- broad purpose to allow for multiple typologies and types to be generated from classical attributes
- the process must be transparent and documented with its confidence explicitly defined
- attributes, as the key feature, are populated, with the information used independent of the scheme and not tied to any technology.

Concepts

The overarching concepts include:

- four scales (levels) apply to the scheme
- the four key terms of the scheme are defined and described, with examples of their use:
    - attribute classification and typology – differences, purpose, and use
    - levels (scales) – use of four levels
    - attributes can be classified into categories independent of one another
    - typologies must have a hierarchy in which rules for combinations of the attributes are applied, based on the purpose of the typology
- categories can exist in tiers, enabling broad groupings or finer delineations at a level
- not all attributes and categories need to be applied in attribute classification and typology
- character attributes are used to describe the main components of waste types
- secondary attributes are used to detail effects that waste has on values

- attribute qualifiers add additional information including anthropogenic and temporal information.

Classification and typology

Classification involves simplifying complex data and information and converting these into practical categories, increasing usability. When data and information are simplified, the detail is often lost (called dimension reduction), however, the ability to convey information is enhanced. These simplifications are used in everyday life. For example, while there are ranges of eye colour in humans, we often refer to the colour of a person's eyes as brown, blue, grey, even though there is a continuum of colours.

Plants and animals are classified by groupings according to shared characteristics (e.g. family, genus). Generalisations may then be made across organisms and groups. A similar principle can be applied to littered and illegally dumped wastes. These wastes can be classified using measurable characteristics, variables or factors, referred to collectively as 'attributes'.

Attribute classification provides definitions and categorisation of components of the littered and illegally dumped wastes, and its underlying attributes, and is the pre-cursor to a typology (see fig.2).

The typology provides the rules to apply to attributes that group similar parts of littered and illegally dumped wastes into types for a particular purpose.

While attributes can be classified into categories, independent of one another, a typology must have a hierarchy in which the attributes are applied, based on the purpose of the typology.

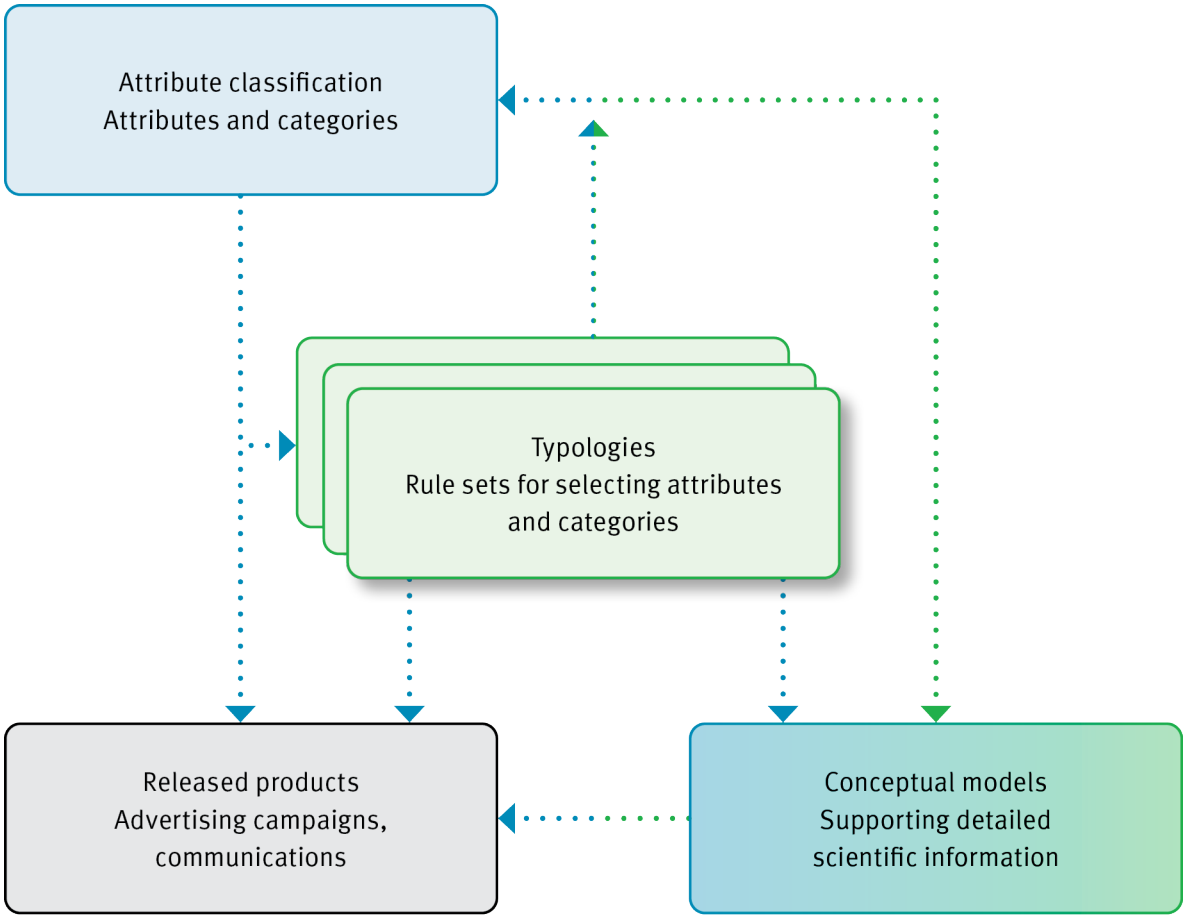

Fig 2: Relationships between attribute classification, typologies and products. Based on The Queensland Intertidal and Subtidal Classification Scheme Version 1.0.

Developing the scheme

Literature review

A literature review was conducted to ensure that the best practice of other schemes were adopted.

The review found that there has been significant research undertaken that targets the management of marine wastes, however, not many systems have been developed to incorporate the terrestrial environment. Very few have incorporated attributes, however, some have used a subset of attributes for specific purposes.

Management frameworks have also been developed. In 2009, the lack of a uniform standard for the measurement and monitoring of marine waste led UNEP/IOC to develop guidelines they hoped could be used worldwide. The aim was for the data and materials collected in accordance with these guidelines to be coordinated with previous measures taken to combat marine litter.

This method is aimed at providing support in:

- quantifying and categorising litter on beaches and develop methods aimed at stopping marine litter
- identifying possible sources of marine litter
- providing comparable data for global, national, regional and local assessments of waste along coastlines
- increasing the general public's awareness of the problem of marine waste along coastlines
- increasing the level of knowledge about how waste along coastlines affects the marine ecosystem.

The difficulties identified with this method for the classification scheme were that it is solely a beach-based measurement and collection system, and that waste buried within the sand is not included.

The primary approach of the UNEP/IOC guidelines was for managing the integration of individual waste assessment activities across broad geographical regions and it did not include an attribute-based classification scheme.

Table 7 lists the original UNEP/IOP report of programs that were investigated when constructing their framework.

Table 7. Marine litter survey protocols that were compared in this study.

Survey name	Short name (acronym)	Source reference
Beach surveys		
Australian Marine Debris Survey	AMDS	Cheshire and Westphalen 2007
National Marine Debris Monitoring Program	NMDMP	US Environment Protection Agency 2002, Sheavly 2007
Northwest Pacific Action Plan (NOWPAP) – beach litter survey	NOWPAP – beach	NOWPAP 2007b
Korean Ministry of Maritime Affairs and Fisheries	KMMAF	MOMAF 2002
International Coastal Cleanup (ICC).	ICC	The Ocean Conservancy 2002
Commission for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Commission).	OSPAR – beach	OSPAR 2007
Commission for the Conservation of the Antarctic Marine Living Resource	CCALR – beach	CCAMLR 2008
World Wide Fund for Nature.	WWF	White 2005
Clean Coast Index.	CCI	Alkalay et al. 2007
Floating litter surveys		
Japan	Japan – floating	Shiomoto and Kameda 2005
Floatables Action Plan	FAP	US Environment Protection Agency 2002, 2007
Benthic litter surveys		
Northwest Pacific Action Plan (NOWPAP) – seabed litter survey	NOWPAP – benthic	NOWPAP 2007a
Marine debris in the Northwest Hawaiian Island	NDNHI	Donohue et al. 2001, Timmers et al. 2005

Two community-based groups that use attributes are the Australian-based Tangaroa Blue Foundation (tangaroablue.com.au) and the U.S based Coastal Observation and Seabird Survey Team (COASST). Both operate mainly with coastal and marine environments.

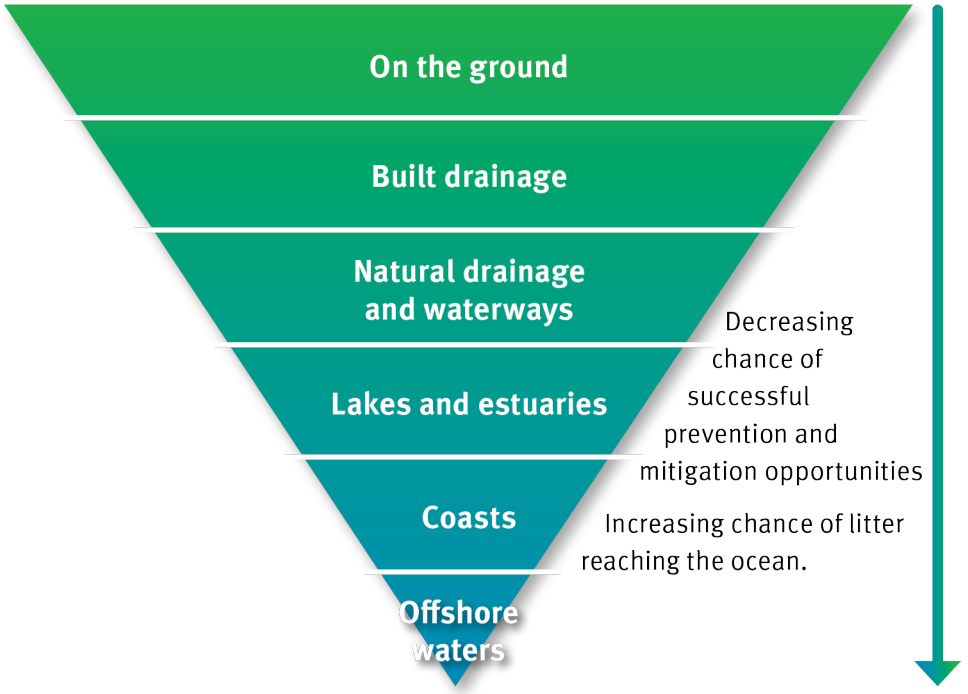

Diagram courtesy of Tangaroa Blue Foundation

COASST collect data on seabird deaths using an attribute-based scheme (Coasst.org) that is similar to the one used in the LIDMF. The Tangaroa Blue Foundation separates waste using attributes when analysing their data.

The LIDMF used the attributes identified in these and other projects as the basis for many of the attributes in this project.

Consultation

This project incorporated significant advice and support from key stakeholders, including university research staff, local and state government staff and managers, consultants, the CSIRO and community based not-for-profit organisations.

Beyond the initial examination of attributes, the collaborators have continued to remain in a reference group throughout the consultation and development of the scheme.

LIDMF Advisory Group and peer review

The LIDMF Advisory Group was formed to oversee the development of the LIDMF and the attribute-based classification scheme. The group provided the role of ensuring effective governance, coordination and strategic direction for the project and included senior officers from:

Department of Environment and Science

- Wetlands, Environmental Policy and Programs
- Litter and Illegal Dumping Programs, Office of Resource Recovery
- Office of the Great Barrier Reef
- QPWA
- Water Quality, Environmental Policy and Programs

External organisations

- Department of Resources
- Department of Transport and Main Roads

- Department of Fisheries and Agriculture
- Local Government Association of Queensland
- Natural Resource Management Regions
- CSIRO

Levels (Scale)

Levels: The LIDMF Attribute-based Classification Scheme uses four levels of scale: Macro, Meso, Micro and Nano.

Four levels were chosen to align with the way data is collected in the field.

Meso (6mm – 1 metre) and Macro (> 1 metre) correspond well with littered and illegally dumped wastes, respectively.

Both micro (1 – 5mm) and nano (1 – 1000mm) materials require different collection methods and have different effects on values, therefore it was determined that these should be separated.

Attributes and their categories are related to spatial scales. Attributes may be related to one or more levels. Where an attribute is related to multiple levels then the categories of the attribute may vary between those levels.

Attributes used in the scheme

Theme	Attribute	Category Name	Metric
Characteristics	Colour	Coloured	Blue
		Coloured	Purple
		Coloured	Red
		Coloured	Black/Brown
		Coloured	Beige
		Coloured	White/Opaque
		Coloured	Orange
		Coloured	Yellow
		Coloured	Green
		Coloured	Multi
		Silver	Silver/Grey
		Transparent	Transparent
	Reflectivity	Yes	Yes
		No	No
	Fluorescence	Yes	Yes
		No	No
	Sharpness	Yes	Yes
		No	No
	Transparency	Yes	Yes
		No	No
	Explosivity	Yes	Yes
		No	No
	3D Shape	Round	Cylinder
		Square	Cube
		Rectangle	3D Rectangle
		Flat	Flat
		Coil	Coil

Theme	Attribute	Category Name	Metric
Characteristics	3D Shape	Asymmetrical	Asymmetrical
		Unknown	Unknown
	Length	Very Long	> 5 metres
		Long	> 1.1 metre – 5 Metres
		Medium	> 50cm – 1 Metre
		Short	2.5cm – 50 cm
		Very Short	6mm – 2.4cm
		Micro	1 – 5mm
		Nano	1 – 1000nm
		Unknown	Unknown
	Carbon Based	Yes	Yes
		No	No
	Elasticity	Strong	Flexible – Tight
		Weak	Flexible – Loose
		Rigid	Rigid
	Plasticity	Yes	Yes
		No	No
	Flexibility	Yes	Yes
		No	No
	Mass	Very Heavy	> 10kg
		Heavy	1kg – 10kg
		Medium Heavy	500g – 1kg
		Medium	50g – 500g
		Light	< 50g
		Unknown	Unknown
	Corrosive	Yes	Yes
		No	No

Theme	Attribute	Category Name	Metric
Characteristics	Buoyancy in Water	Positive Buoyancy	Positive Buoyancy
		Neutral Buoyancy	Neutral Buoyancy
		Negative Buoyancy	Negative Buoyancy
	Leachability	Very Fast	< 1 day
		Fast	1 day – 1 month
		Slow	> 1 month
		Unknown	Unknown
		None	None
	Fragmentation Potential	Yes	Yes
		No	No
	Fragmentation Product	Yes	Yes
		No	No
	Decomposition Time	Never	Never
		Very Long	> 10 years
		Long	1 year – 10 years
		Medium	6 months – 1 year
		Short	< 6 months
		Unknown	Unknown
	Toxicity	High Risk	ERA Category 1
		Medium Risk	ERA Category 2
		Low Risk	Not Regulated
	Flammable	Yes	Yes
		No	No
	Invasive Plant	Yes	Yes
		No	No
Effects on Values	Human Health	Affected	Yes
		Not Affected	No

Theme	Attribute	Category Name	Metric
Effects on Values	Entanglement Potential	Yes	Yes
		No	No
	Ingestion Potential	Yes	Yes
		No	No
	Suffocation	Yes	Yes
		No	No

Attribute terms

Terms of the Attribute classification include:

- **Attribute themes** – broad groups used to describe attributes e.g. terrain, substrate, energy, hydrology (physical/chemical) and biota.
- **Attributes** are descriptive characteristics such as its flammability or length. An attribute may be a mathematical or statistical indicator, or characteristic used to describe characteristics in order to classify them (e.g. length can be seperated by <2cm, 2-10cm etc).
- **Categories** – a list of discrete values for an attribute, which provide for the complete domain of the attribute and are mutually exclusive.
- **A Metric** is a specification for how an attribute will be measured. It may be binary ('yes' or 'no', 'present' or 'absent'), a ranking (high, medium, low), or a number (Aquatic Ecosystem Task Group 2012).
- **Threshold** is a 'cut-off' value that is applied to divide continuous metrics of an attribute into groups, creating discrete values for a category.

References

Sherrington, C. (2016). Plastics in the Marine Environment. Eunomia. https://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/