UN environment programme

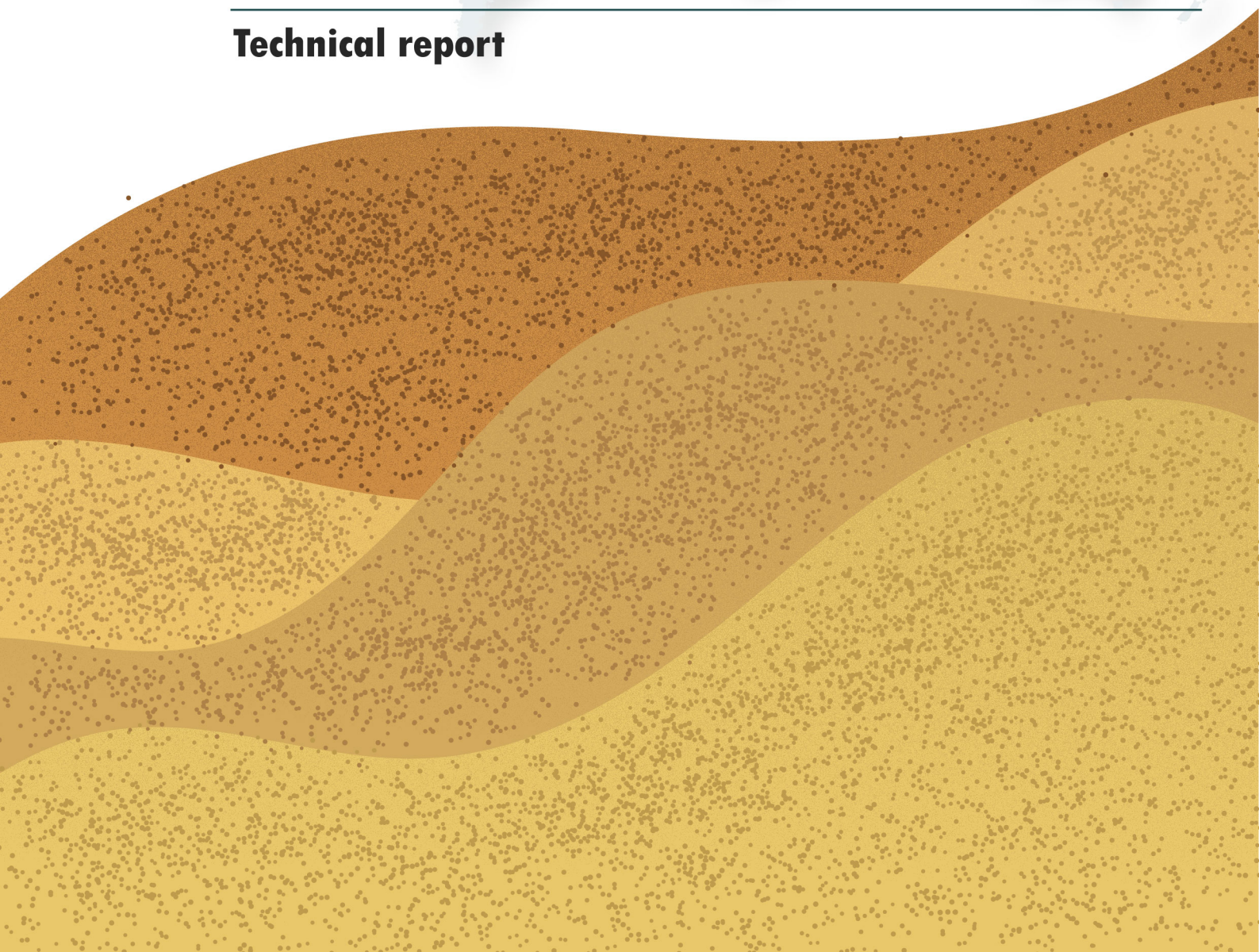
GRID Geneva

GLOBAL SAND ANALYSIS SERIES

What is sand?

Results from a UNEP / GRID-Geneva expert discussion

Technical report



About UNEP/GRID-Geneva

GRID-Geneva is part of the UN Environment Programme Science Division and a member of the Global Resource Information Database (GRID) network. Established as a partnership between the United Nations Environment Programme (UNEP), the Swiss Federal Office for the Environment (FOEN) and the University of Geneva (UniGe). With a team of 20 Environment Data Scientists, GRID-Geneva transforms data into information and knowledge to support the decision-making process related to environmental issues.

About this document

The Global Sand Observatory Initiative (GSOI) is UNEP/GRID-Geneva's response to requests to identify knowledge gaps under the UNEA-4 Mineral Resource Governance resolution (UNEP/EA.4/Res.19).

The discussion on the impacts of sand and gravel extraction, recycling, use, and re-use is a new issue for the international community. This technical report draws on the rich and diverse body of terms from different stakeholders. Within the framework of the GSOI, UNEP/GRID-Geneva reviewed and assessed this terminology. An expert group was convened in December 2020 to begin a series of technical discussions on "what is sand"?

This document reports on the first discussion structured around four key terms: 1) sand; 2) gravel; 3) rock; 4) aggregate and a set of associated terms. This discussion was moderated under the Chatham House Rule. As such, no particular view or comment is attributed to any one participant.

Following the UNEA-5 Minerals and Metals Management resolution (UNEP/EA.5/Res.12), this living document will be updated as required, and in consultation with UNEP/GRID-Geneva's experts network. We invite all comments and feedback to be sent to sand@unepgrid.ch.

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This document is designed as a digital resource not intended for print. APA style (7th edition) applies for references.

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Abbreviations

ASTM	ASTM International is one of the largest voluntary standards developing organizations in the world. A not-for-profit organisation headquartered in the United States, ASTM provides a forum for the development and publication of international voluntary consensus standards for materials, products, systems, and services. Its volunteer members represent producers, users, consumers, government, and academia from more than 140 countries.
BGS	The British Geological Survey is a world-leading geological survey and global geoscience organisation, focused on public-good science for government and research to understand earth and environmental processes.
GOST	Refers to a set of technical standards maintained by the Euro-Asian Council for Standardization, Metrology and Certification (EASC), a regional standards organization operating under the auspices of the Commonwealth of Independent States (CIS) formed by post-Soviet republics in Eurasia. GOST standards were originally developed by the USSR as part of its national standardization strategy.
ISO	International Organization for Standardization. ISO is an independent, non-governmental international organization with a membership of 165 national standards bodies.
PIANC	PIANC is the World Association for Waterborne Transport Infrastructure, established in 1885. Their high-ranking technical reports on the design, development, and maintenance of ports, waterways, marinas, and coastal areas are renowned and provide the global waterborne transport community with expert guidance, recommendations, and technical advice.
USGS	The United States Geological Survey is a scientific agency of the US Government. USGS is a bureau of the US Department of the Interior, the sole scientific agency.

1 Introduction

After water, *sand, gravel, and crushed rock* are the most exploited natural resources in the world and their use has tripled in the last two decades to reach **40-50 billion metric tons per year.**

The management of sand and gravel resources are gaining international recognition as an emerging sustainability challenge following the 4th United Nations Environmental Assembly in 2019. Although attention on this topic continues to grow at the multilateral level, there are **no universally accepted and commonly used terminology and basic definitions**, including of sand itself. Defining an appropriate vocabulary consisting of terms and definitions that are precise and universally accepted is becoming ever more important.
The absence of agreed terminology across regions and different industries presents **an obvious problem**: valuable data on mineral resources, trade and environmental resilience is often unreliable and as such will continue without agreed upon definitions and terminology.

Therefore, UNEP/GRID-Geneva convened a virtual discussion on 3 December 2020 with 14 experts from a range of public and private, scientific, and technical entities with **two objectives:**

1. To review the existing terminology and definitions around sand, gravel, rock, and aggregate as a material within the framework of extraction and use.

2. To create a common understanding on the language used for classification and common terminology, serving as a reference point for UN Environment and other stakeholders; to be used within the framework of mineral resources, trade and environmental resilience policy making, i.e., not as a technical specification for a specific engineering application such as "sands for mortar production".

The aim of this review is to create a generally accepted list of terminology and definitions for sand, gravel, rock, and aggregate as a reference point for the UN Environment Programme, national governments, and other stakeholders within the framework of mineral resources governance, trade, environmental resilience policy making and general use. This document is not intended for specific engineering or other technical applications.

2 Why are there differences in definitions?

When it comes to the classification and description of soil, rock and granular material used for engineering applications, three **standards institutes** set the scene internationally: the International Organization for Standardization (ISO), ASTM International, and the Euro-Asian Council for Standardization, Metrology and Certification (GOST). Their technical standards for soil, sand and gravel overlap but are different in meaningful

ways. In addition, there is a rich and diverse vocabulary which varies from industry to industry and from region to region.

The experts engaged in this review were asked:

What is your understanding as to why different entities choose one standard over another?

Experts reflected that differences arise due to a number of factors, including:

- The use of sand in very different industries which automatically results in different standards.
- Convention, driven by different building traditions, which in turn evolved with different locally available raw materials and measurement systems, that evolved into norms.
- Formalised accepted standards that are reinforced by legal requirements used as national standards in various countries.
- Country-specific geological and geographical conditions and the associated hazards influence building codes/design manuals, which subsequently has an influence on the definition of soil and rock. For example, a country prone to earthquakes will pay particular attention to the percentage of fines content in defining sand and gravel as this will dictate the behaviour of materials in the event of an earthquake.

3 Review of key terms

3.1 Sand

Issue summary

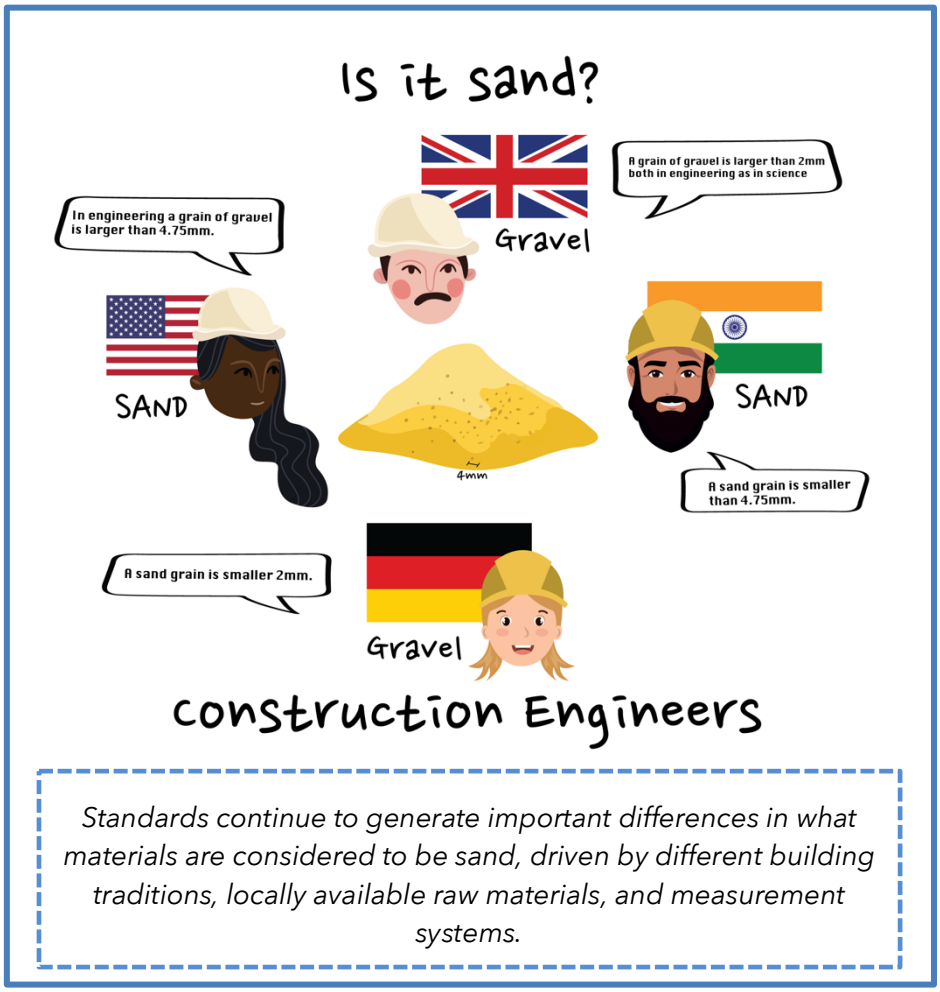
Sand is normally understood to be either i) a size fraction or ii) a coarse mineral granular material which does not stick together when wet and remoulded, and where the combined weight of 50% of the particles is smaller than 2mm (ISO) or 4.75mm (ASTM) and larger than 63 μm (ISO) or 75 μm (ASTM). The definitions provided by technical standards for sand are different in meaningful ways and often vary from industry to industry and region to region with regards to grain-size fraction boundaries, (mineral) composition and mechanical properties.

Table 1 below provides definitions **derived from eight geotechnical standards for "sand".** These varied definitions continue to generate important differences in what materials are considered to be sand, not depending on the material itself but on the country or region in which it is being used.

Review of definitions for sand in current significant technical standard systems

Region / country	Standard	Definitions A soil[1] is called a sand if…
European Union	EN ISO 14688-1:2018	…it is a coarse, natural mineral soil which does not stick together when wet and remoulded (i.e., non-cohesive) and where the combined weight of 50% of the particles is smaller than 2mm.
United States of America	ASTM D2487-00 ASTM D2488-00 ASTM D 653- 02	…more than 50% is retained on n°200 sieve (75µm) and 50% or more of the coarse fraction passes the n°4 (4.75-mm) sieve. Note: ASTM D 653-02 defines sand more narrowly as particles of rock that will pass the n°4 (4.75-mm) sieve and are retained on the n°200 (75-µm) U.S. standard sieve.
United Kingdom	BS 5930:2015	…it is a mineral soil, when saturated and unconfined, cannot sustain negative pore pressures and thus has no undrained strength or apparent cohesion, and for which 50% (by weight) of the particles are larger than 63µm but smaller than 2mm. Note: This definition is identical to EN ISO-14688 but with nuances which allow for an alternative definition.
Australia	AS 1726:1993	…it is a coarse-grained soil for which more than half of the coarse fraction (by weight) is smaller than 2.36mm, with a "coarse-grained soil" defined as a soil where more than half of material less than 63mm is larger than 0.075mm. Note: Adaptations were made in 2017.
Russia	GOST 25100:2011	…it is a non-cohesive mineral soil with more than 50% particles finer than 2mm (Ip < 1%.).
India	IS 1498:1970	…it is a coarse-grained soil for which more than half the coarse fraction (>75µm) is smaller than the 4.75mm IS Sieve size. This subdivision includes sands and sandy soils. In the Indian Standard "coarse-grained soils" are defined as soils for which more than half the total material by weight is larger than 75-micron IS Sieve size.

[1] **(*)** Soil is often named after its primary size fraction and is often ambiguous as to whether we can treat sand as a soil class or not.



Standards continue to generate important differences in what materials are considered to be sand, driven by different building traditions, locally available raw materials, and measurement systems.

Expert group recommendations for definition on "sand"

- Subdivide the grain-size fractions to be defined as per the Unified Soil Classification System (ASTM D2487-00) which is linked to the US standard sieve sizes.
- Define a quantitative lower grain size boundary for sand.
- Define a maximum percentage of fines- as not to solely rely on a qualitative description of the mechanical behaviour when making a subdivision between classes of clay/silt and sand.
- Use a conservative upper limit for the percentage of fines to minimise the reliance on a qualitative description of the cohesive behaviour of a material to reduce subjectivity. An upper limit of 15% is put forward on the notion that if the percentage of fines is higher than 15%, the material might behave more like clay or silt than sand. This is particularly true if the grain-size distribution is gap-graded.
- Retain a broad definition and avoid an overly strict, all-encompassing definition. The definition should allow for a more precise description using secondary qualifiers which might refer to minor grain-size fractions and material characteristics such as shape, colour and/or specific mineral composition.

- Allow in the definition for sand not derived from rocks. In various regions sand is biogenic in origin (e.g., derived from corals) or the result of chemical processes (e.g., ooid sand) and thus not derived from rock.

A proposed definition for "sand"

Term	Sand
Proposed definition	Sand is a mineral granular material which does not stick together when wet and remoulded (i.e., non-cohesive) and where the combined weight of 50% of the particles is smaller than 4.75mm, with less than 15% of material smaller than 75µm. For a precise and correct description of sand, secondary qualifiers are highly recommended.
Builds upon	ASTM D2487-00 / ASTM D2488-00 for grain size boundaries; and EN ISO 14688-1:2018 for wording
Rationale	The definition is kept general and can be supplemented with additional qualifying terms to better describe a certain material. The definition leaves room for a broad group of solid, naturally occurring inorganic materials to be described as sand. This includes materials that do not fit entirely within the grain-size fraction of sand, sand that is not derived from rocks (e.g., biogenic in origin), and sand obtained from crushing rocks or gravel. It does however put a rather strict quantitative upper limit of 15% on fines to ensure materials which may behave cohesively cannot be described as sand. In the same spirit, the condition that the material "does not stick together when wet and remoulded" is to prevent sand-sized granular materials such as clay pellets to be described as sand.
Example	If a non-cohesive mineral granular material would consist of particles with a D50 smaller than 2mm and 20% of the particles finer than 63 µm, this would be defined as sand under the original ISO and ASTM definitions. With the new qualifier of 15% for fine particles, it is then no longer considered as sand. Most standards for specific applications of sand limit the percentage of fines to 15% or lower for various reasons.

Additional points raised by experts

During the discussion, a number of additional points and questions were raised by the expert group, which are worth noting for future discussions:

- With the addition of the 15% fines qualifier, the condition for the material "not to stick together when wet and remoulded" may be obsolete unless the final clause is adjusted further to state: "less than 25% of material smaller than 75µm".
- If 50% of the material is blocked by the n°4 (4.75 mm) sieve, then this means it could be a very heterogeneous material with large fragments. For some experts, sand is a material that passes the n°4 sieve and is blocked by the n°200 sieve or at least a more homogeneous material class with no more than 15% of the coarse fraction larger than 4.75mm.
- Many countries and existing standards do not use the grain-size fraction as per American Standard sieve size and this will be a practical consideration for the application of these definitions in practice.

When reviewing the term "sand", experts noted a number of additional questions and points including:

- The engineering behaviour of the material should not be the sole consideration for determining the upper limit of fines. Several experts pointed out that the proposed 15% upper limit of fines might be too restrictive and will have important implications for materials with a slightly higher percentage of fines that are currently used as sand and do not behave cohesively. There could also be implications for the sand export bans on materials with fines content between 15-25%, a range that is currently within the ISO and ASTM definition of sand.
- To make explicitly clear in the definition whether it includes or excludes "sand" produced from crushing rock, recycling, or secondary sources, in line with the proposed definition of aggregates.
- The definition takes a more geotechnical perspective which is not very tailored to certain fields of research. One such example is the mapping of sediments as a substrate for marine ecosystems which currently makes use of various Folk classifications.

3.2 Gravel

Issue summary

Gravel is normally understood to be either i) a size fraction or ii) a coarse, mineral granular material which does not stick together when wet and remoulded and where the combined weight of 50% of the particles is larger than 2mm (ISO) or 4.75mm (ASTM) and smaller than 63 mm (ISO) or 75 mm (ASTM). The definitions provided by technical standards for gravel overlap but these definitions are different in meaningful ways. They often vary from industry to industry and region to region with regards to grain-size fraction boundaries, mineral composition, and mechanical properties. The issues around defining "gravel" is thus largely the same as it is for "sand".

Expert group recommendations for definition on "gravel"

- Subdivide the grain-size fractions to be defined as per Unified Soil Classification System (ASTM D2487-00), which is linked to the U.S. standard sieve sizes.
- Define a maximum percentage of fines as not to solely rely on a qualitative description of the mechanical behaviour when making a subdivision between classes of clay/silt and gravel.
- Use a conservative upper limit for the percentage of fines to minimise the reliance on a qualitative description of the cohesive behaviour of a material, thus, to reduce subjectivity. An upper limit of 15% is put forward on the notion that if the percentage of fines is higher than 15%, the material might behave more like a clay or silt than gravel. This is particularly true if the grain-size distribution is gap-graded.
- Keep the definition general and do not aim for an overly strict, all-encompassing definition. The definition should allow for a more precise description using secondary qualifiers which might refer to minor grain-size fractions and material characteristics such as shape, colour and/or specific mineral composition.

Proposed definition for "gravel"

Term	Gravel
Proposed definition	Gravel is a mineral granular material which does not stick together when wet and remoulded (i.e., non-cohesive) and where the combined weight of 50% of the particles is larger than 4.75mm but smaller than 75mm with less than 15% of material smaller than 75µm. For a precise and correct description of gravel, it is highly recommended to use secondary qualifiers.
Builds upon	ASTM D2487-00 / ASTM D2488-00 for the grain size boundaries EN ISO 14688-1:2018 for the wording
Rationale	The definition is kept general and can be supplemented with additional qualifying terms to better describe a certain material. The definition leaves room for a broad group of solid, naturally occurring inorganic materials to be described as gravel. This includes materials that do not fall 100% within the grain size range of the gravel fraction, gravel that is not derived from rocks (e.g., biogenic calcium carbonate gravel), and gravel obtained from crushing hard rocks. It does, however, put a rather strict quantitative upper limit of 15% on fines to ensure materials which may behave cohesively cannot be described as gravel. In the same spirit, the qualitative description that the material "does not stick together when wet and remoulded" is to exclude gravel sized granular material such as clay pebbles to be described as gravel.
Example	If a non-cohesive mineral granular material would consist of particles with a D50 larger than 5 mm and 20% of the particles finer than 63 µm, this would be defined as gravel under the original ISO and ASTM definitions. With the new qualifier of 15% for fine particles, it is no longer considered as gravel. This is however in line with most technical standards for specific applications of gravel which tend to limit the percentage of fines to 15% or lower for various reasons.

Additional points raised by experts

When discussing the term "gravel", experts noted a number of additional questions and points including:

- With the addition of the 15% fines qualifier, the middle part referring to the cohesive nature of the material in the definition may be obsolete unless the final clause on fines is adjusted further to state: "less than 25% of material smaller than 75µm".
- If 50% of the material is blocked by the 75 mm sieve and a sieve larger than n°4 (4.75 mm), then this means it could be a very heterogeneous material. For some experts, gravel only includes material that passes the 75 mm sieve and is blocked by the n°4. This view in essence expresses that gravel is best regarded as a grain-size fraction and not a material or soil class.
- Many countries and existing standards do not use the grain-size fraction as per American Standard sieve size and this will be a practical consideration for the application of these definitions in practice.

When reviewing the term "gravel", experts noted a number of additional questions and points including:

- The engineering behaviour of the material should not be the sole consideration for determining the upper limit of fines. Several experts pointed out that the proposed 15% upper limit of fines might be too restrictive and will have important implications for materials with a slightly higher percentage of fines that are currently used as gravel. The exclusion of materials with a fines content between 15-25% could also have implications for the current trade restrictions on gravel.
- To make explicitly clear in the definition whether it includes or excludes "gravel" produced from crushing rock, recycling, or secondary sources, in line with the proposed definition of aggregates.
- The definition takes a more geotechnical perspective which is not very tailored to certain fields of research. One such example is the mapping of sediments as a substrate for marine ecosystems which currently make use of various Folk classifications.

3.3 Rock

Issue summary

The term rock has a different meaning depending on the industry, region, and use. The differences in interpretation of what a rock constitutes, and how it is described, are particularly clear between the field of geology and engineering. For the latter, the mechanical property is one of the most important characteristics in determining whether a material is a rock, whereas in geology, attributes such as consolidation, texture, chemical composition, and mineralogy are key.

Expert group recommendations for definition on "rock"

- Include in the definition of rock a characteristic on bonding, preferably excluding bonding by water or hydromechanical processes.
- Formulate a definition which does not depend on where or in what shape a rock can occur. In other words, the definition of rock does not need mentioning that it can or cannot occur as isolated cemented nodules, boulders, or slabs within a sediment and in solid bedrock mass.
- Include the two-way process of how rocks can transition into soil, and how soil can transition into rocks, through a variety of physical, chemical, biological, and climatic processes.
- Indicate that intermediate materials can be both soil/sediment and rock because transitions are gradual and overlapping.

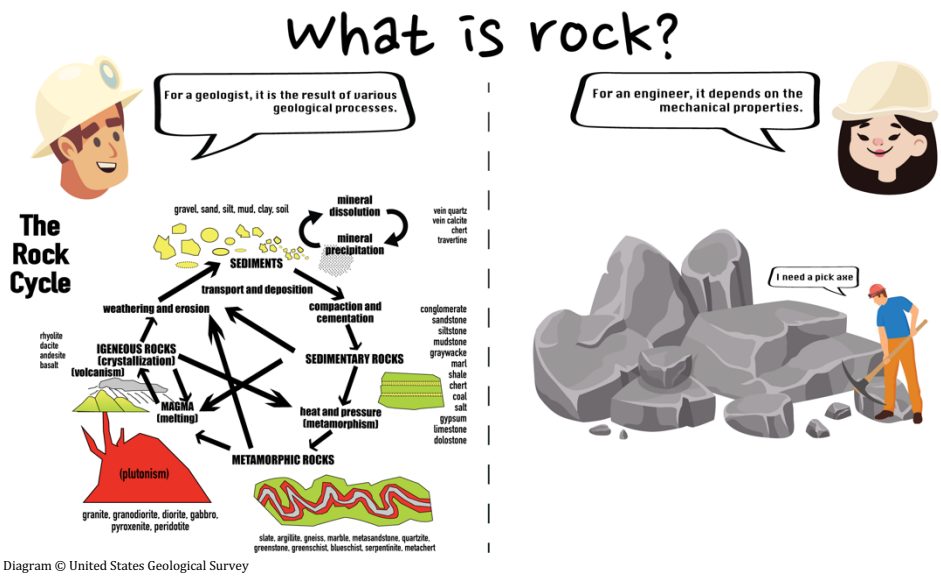


Diagram © United States Geological Survey

The term rock has a different meaning depending on the industry, region, and use. The differences in interpretation of what a rock constitutes, and how it is described, are particularly clear between the field of geology and engineering.

Proposed definition for "rock"

Term	Rock
Proposed definition	A geological material is a rock when the constituent grains or minerals are bonded and form a solid framework that has tensile strength other than through bonding by water, hydromechanical processes, van der Waals attraction or electrical double-layer repulsion. The two-way transition from unconsolidated accumulations of mineral sediment or soil grains or minerals to rock is gradual. The transition can occur through a variety of physical, chemical, biological, and climatic processes.
Builds upon	PIANC 2017 and Lu, N., and Likos, W. J. (2006).
Rationale	The discussion on the transition from sediment/soil to rock is a hotly debated issue between different experts and is of relevance to the discussion on sand. We hope that the reference to a "geological material" and the use of tensile strength as a determining factor—instead of "Unconfined Compressive Strength"—might provide a definition more acceptable to all.
Example	A material of rounded gravel cemented in a finer matrix of fine sand-sized mineral grains cannot be described as a rock if it is man-made (e.g. concrete), while it would be considered a rock if it is a geological material, such as a conglomerate.

Additional questions and points raised by experts

A key question which emerged during the discussion was: does the strength parameter for rock need to be specified in more quantitative terms? This question should be included in any future discussions.

When reviewing the term "rock", experts noted a number of additional questions and points including:

- To consider that constituent grains or minerals are bonded **and/or interlocked.**
- To make clear that a rock is a consolidated material.
- To provide a clear motivation to the terms sediment and soil and to why the terms are used in the definition of rock.
- To substitute "unconsolidated accumulations of mineral sediment or soil grains or minerals" by "unconsolidated mineral formations" to avoid the use of the terms "soil" and "sediment" as the definitions of soil and sediment vary between various disciplines.
- To simplify the current definition, which is very technical and may be difficult to understand.
- To reconsider the tensile strength as the qualifying parameter as the definition cannot be evaluated easily. Some experts note that although tensile strength is an important qualifier, there are

qualifiers they consider to be more important. Two alternative definitions were proposed:

- A geological material is a rock when the constituent grains or minerals are bonded and form a solid framework that cannot be broken easily by hand.
- A rock is a natural, solid, assemblage of minerals and/or components of inorganic origin that has a variable degree of tensile strength.

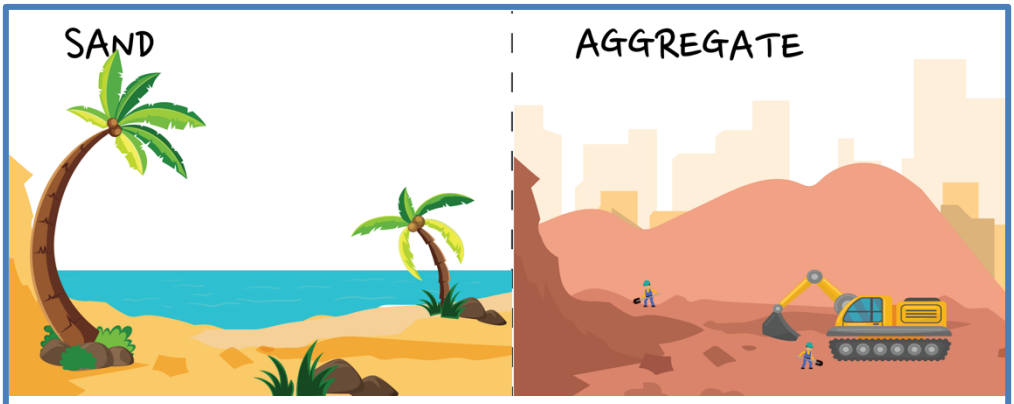
3.4 Aggregate

Issue summary

The issue around defining "aggregate" is broadly the same as it is for sand, gravel, and rock, where the term has different meanings in different industries, uses and regions.

Expert group recommendations for "aggregate"

When it comes to the general definition for "aggregates", the group recommended adding the word "essentially" to indicate that aggregates—whatever its source—are in essence destined for construction purposes, although not exclusively so.



Proposed definition: Aggregate is a granular material of natural, processed, or recycled origin used essentially for construction purposes with an upper grain size limit of 75mm

Proposed definition for definition on "aggregate"

Term	Aggregate
Proposed definition	Aggregate is a granular material of natural, processed, or recycled origin used essentially for construction purposes with an upper grain size limit of 75mm
Builds upon	ISO 19595:2017, EN 12620:2002 & EN 13043:2002
Rationale	The definition provided is somewhat broader but not in contradiction with the definition provided by ASTM D0653-02, except for the specification of an upper size limit. Unlike the definition formulated for rock, sand and gravel, this definition does not incorporate the word "mineral" with the understanding that a mineral is a naturally occurring inorganic element or compound, having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.
Example	Although sand and gravel are typically used as aggregates, other materials which do not consist of mineral grains can be used as aggregates too, an example is the use of fly ash or steel slag whose grains are often amorphous.

Additional questions and points raised by experts

When reviewing the term "aggregate", several experts noted a need for a definition of the term "crushed rock". The term is commonly used in the aggregates and construction sector.

4 Review of associated terms for "sand", "gravel" and "aggregates"

Definitions of important terms commonly used to characterise types of "sand", "gravel", and "aggregates", which are linked to the source of origin or the intended use of these materials, are also required. Clarifying these associated terms matters greatly for improving data collection and classification on the environmental, social, and economic impacts of sand extraction, and subsequently, developing clear sustainable development strategies that are shared by all stakeholders.

4.1 Sources and uses of sand and gravel

Issue analysis

Sand, gravel, and aggregates are very broad groups of materials in terms of the differences in their physical and chemical characteristics. Depending on these characteristics, sand, gravel, and aggregates are

associated with different sources and end-uses. In statistical classifications, policy papers, standards and technical documents, authors often refer to words associated to certain applications or to specific sources to help them better categorise certain types of sand, gravel, and aggregates.

However, many of these terms are not used consistently and vary depending on the region, the industry and even the context in which they are used, resulting in inconsistencies between datasets, policies, and technical guidelines.

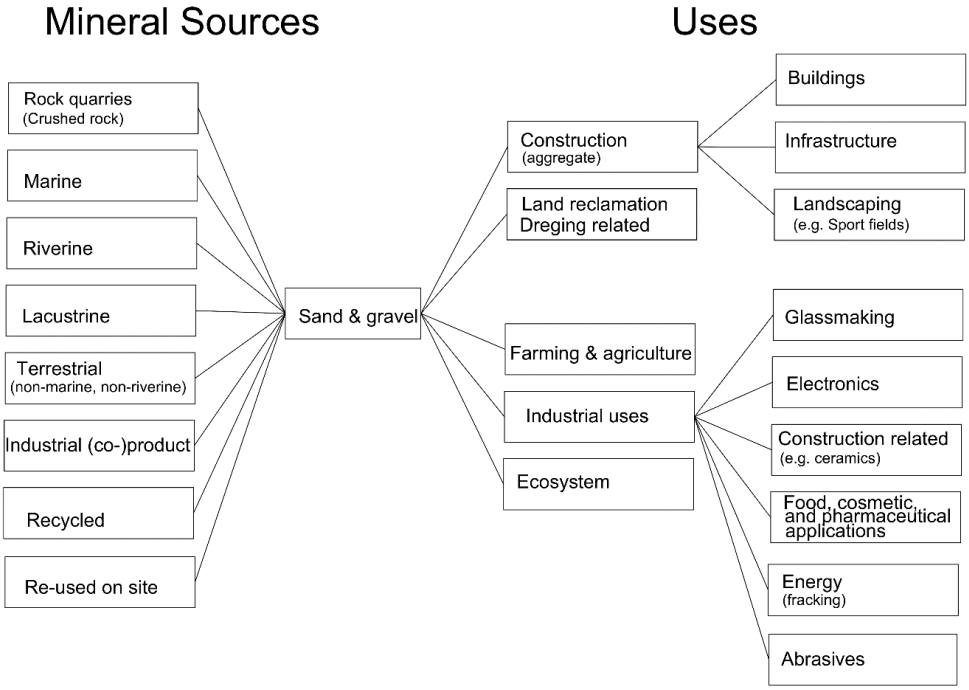


Figure 1 A preliminary listing of the key sources and uses for sand & gravel

This figure is adapted from "An early exploration of data availability for the creation of an inventory on sand extraction and tracking resources status. Part 2: Best available quantitative assessments of sand production, trade and consumption" by UNEP/GRID-Geneva (Forthcoming) using the input of the expert group convened on December 3, 2020.

4.2 Natural

Issue summary

The term "natural" is used to make a distinction between sand, gravel and aggregates which are:

- Directly sourced from the natural environment (e.g., rivers) as opposed to sand, gravel and aggregates being reused or derived from waste streams.
- Derived from the natural disintegration of rocks as opposed to sand, gravel and aggregates which are the obtained from crushing rock (e.g., BS 1199 and 1200:1976, ASTM C125-10).
- Sourced from the natural environment (including rocks) and have been merely subjected to mechanical processing, such as crushing, washing, and sieving, as opposed to sand, gravel and aggregates which are derived from industrial processes involving thermal or other modification, or any other sources not deemed natural (e.g., ISO 19595:2017, EN 12620:2002 & CIRIA et al., 2007).

Expert views on "natural"

The experts agreed that the term "natural sand/gravel/crushed rock" is ambiguous, an opinion reflected by the inconclusive vote. Based on the issue statement and the discussion, the experts expressed that it is better to avoid the use of the term "natural" as an adjective/descriptor of sand/gravel or aggregates. Instead, the terms "industrially processed", "crushed rock/stone", "naturally-occurring" and "sourced from the natural environment" could be used.

Recommendations

Experts agreed that terms like "naturally-occurring sand" or "sand sourced from the natural environment" is preferable over "natural sand", which is too ambiguous.

4.3 Manufactured

Issue summary

Depending on the industry and the region, the word "manufactured" takes on different meanings. This is well illustrated for the word "manufactured" in conjunction with fine aggregates used in concrete. According to the EN 12620:2002, a manufactured aggregate is a granular material of mineral origin that is the result of an industrial process involving thermal or other modification; whereas according to the ASTM C33-13 and ASTM C125-10, manufactured sand (in the context of being an aggregate for concrete) is defined as a fine aggregate obtained by "crushing rock, gravel, iron blast-furnace slag or hydraulic-cement concrete". The aggregates industry, on the other hand, usually describes manufactured sand as a crushed fine aggregate produced from a suitable source rock for the

purpose of being used as an aggregate (e.g., Cement Concrete & Aggregates Australia, 2008). This production process generally also involves screening and possibly washing.

Expert views on "manufactured"

Opinions diverged on the use of the term "manufactured", however, experts had a slight preference for the definition that includes "the mechanical crushing of rock or an industrial process involving thermal or other modification".

Recommendation

Based on the issue statement and the discussion, experts reached the conclusion that it would be best to avoid the use of the term "manufactured" and instead, use terms such as "industrially processed" and "crushed rock/stone" sand/gravel/aggregates.

4.4 Secondary

Issue summary

The term "secondary", used in conjunction with (raw) materials or aggregate, is often used in policy documents and industry guidelines but rarely mentioned in technical standards. The term is used to indicate materials/aggregates produced as a by-product of other activities or to indicate raw materials/aggregates which have been recovered from a waste stream. Similarly, recycled materials and aggregates are materials that have been collected and separated from a waste stream and have undergone some form of further processing for the purpose of being used again. However, it is not universally agreed upon as to whether recycled materials can be considered as secondary material.

In many UK Government policy papers (e.g., Derbyshire County Council et al., 2020), a difference is made between recycled and secondary aggregates/raw materials. However, the European Commission defines secondary raw materials as "materials that can be recycled and then injected back into the economy as new raw materials" (European Commission, 2015). Many other governmental or institutional examples can be drawn upon but also from the industry. According to the Union Européenne des Producteurs de Granulats (Union Européenne des Producteurs de Granulats, n.d.), secondary aggregates include both recycled and re-used aggregates with recycled aggregates, aggregates that are reprocessed materials previously used in construction. On the other hand, the Construction Industry Research, and Information Association (CIRIA et. al, 2007) makes a clear difference between recycled and secondary materials in their leading publication "The Rock Manual" (CIRIA et al., 2007).

Expert views on "secondary"

From the voting results, experts expressed a clear preference to use "secondary aggregates/raw materials" as an umbrella term which includes both recycled and reused raw materials/aggregates.

Recommendations

- Secondary aggregates/raw materials can include both recycled and reused sand.
- The term "recycled" should not be used to describe any "manufactured aggregates", nor should they be considered to be part of the same category. While construction demolition debris is often crushed or otherwise processed, it is considered as recycled (and not manufactured) by the industry, irrespective of the definition used.

4.5 River sand

Issue summary

Sand transported in river systems is deposited on riverbeds but also in deltas, estuaries, floodplains, and lakes. River sand is a term that is commonly used but, what is (and is not) considered "river sand"?

Expert views on "river sand"

Most experts believed that sand sourced from estuaries, deltas and river floodplains can be considered river sand. The denotation of river sand for sand sourced from lakes could clearly lead to confusion.

Recommendations

The term "river sand" can be safely used for sand derived from river channels, estuaries, deltas, and river floodplains but is preferably not used to refer to sand sourced from lakes. In this case, it is safer to use the term "lacustrine sand".

Further notes upon expert review

In addition, it was noted that a clear distinction should be made between the environment where it has been deposited (e.g., several thousands of years ago) and the environment it is sourced. Without this distinction the term "riverine sand" would be imprecise.

4.6 Marine sand

Issue summary

Sand transported in the marine environment is being deposited at sea and along the beaches, in estuaries, bays and lagoons, reworked again by the sea and redeposited at other locations. Marine sand is a term that is commonly used but, what is (and is not) considered "marine sand"?

Expert views on "marine sand"

Most experts believed that sand sourced from beaches, bays and lagoons can be considered marine sand. The denotation of marine sand for sand sourced from estuaries, tidal wetlands including mangrove swamps could however lead to confusion.

Recommendations

- The term marine sand can be safely used for sand derived from near- and offshore deposits, beaches, bays, and lagoons but preferably not used to refer to sand sourced from estuaries and tidal wetlands, including mangrove swamps.
- Beach-derived sand as different to other marine-origin sand is meaningful, whilst still noting that many beaches are nourished with marine sands.

Further notes upon expert review

Several experts noted that it would be desirable to make a difference between beach and marine sand, from both a technical and sustainability/environmental management point of view. From a technical point of view, the experts noted that beaches are dynamic coastal transition zones between the terrestrial and marine environments, therefore not exclusively part of the marine environment. From a sustainability point of view, the experts noted that beach mining could potentially create significant environmental/social impacts, particularly associated with coastal erosion.

In addition, it was noted that a clear distinction should also be made between the environment where it has been deposited (e.g., several thousands of years ago) and the environment it is sourced. Without this distinction the term "marine sand" would be imprecise.

4.7 Silica sand

Issue summary

The term "silica sand" is often referenced in industrial guidelines when a high silica content and low levels of chemical impurities are required. If glass making is the end use, then 95% of silica is a minimum, whereas for filtration sand this would be 80% (e.g., EN 12904:2005). These standards raise the question of whether there is a strict lower limit for silica content in "silica sand" or whether such a limit would be desirable.

Expert views on "silica sand"

The vote was inconclusive with 30% of experts having no opinion on the question and the remainder of the vote split on whether silica sand should be considered sand with a silica content of at least 95% of silica or without a sharply defined lower limit.

Recommendation

The term silica sand should be taken up in a wider/ future discussion.

Further notes upon expert review

It might be useful to standardize qualifiers like high purity, ultra-high purity, etc.

4.8 Industrial sand

Issue summary

The terms "industrial sand" and "silica sand" are often used interchangeably (e.g., United States Geological Survey, n.d. and The British Geological Survey, 2020) but certain users—including industry and government organisations (e.g., 't Hoen, J., 2017)—differentiate between these two types of sand. Are both terms interchangeable, and if not, how should we define "industrial sand"?

Expert views on "industrial sand"

The vote indicated that for most experts the terms "industrial sand" and "silica sand" are not interchangeable and that industrial sand or gravel is any sand/gravel used for industrial applications, as opposed to construction sand and sand used for land reclamation.

Recommendations

The terms "industrial" and "silica" should not be used interchangeably, in line with the expert opinion mentioned above. Industrial sand or gravel is any sand/gravel used for industrial applications, as opposed to construction sand and sand used for land reclamation.

5 Conclusions and next steps

Defining what we mean by sand is a complex task. However, experts consulted to date seem to be converging on one key message: it is time to find consensus and to create clarity on the terminology that we use wherever possible.

Defining an appropriate vocabulary consisting of terms and definitions that are precise and universally accepted is becoming ever more important. The process covered in this report has shaped a broad agreement on the four key terms: "sand", "gravel", "aggregates" and "rock", and clarified important associated terms such as "marine sand" and "industrial sand".

Closing observations offered by the group of experts:

- The mineral and metals industry is currently in need of a thorough semantic review and this discussion was a positive collective experience that should be used as a model.
- For boundaries in sand and gravel definition, the preference is to use ASTM allowing for the possibility to mix these with ISO standards in a constructive way.
- There is a need for more general definitions. While these are not always adequate for certain engineering applications or scientific fields, more general definitions lead to the possibility of finding more common ground between diverse stakeholders.

5.1 Next steps for this review

This living document will be updated as required and in consultation with our growing network of experts. We invite all comments and feedback to be sent to **arnaud.vandervelpen@unepgrid.ch.**

5.2 UNEP/GRID-Geneva global future sand reviews

We require new language when addressing new challenges. We are still lacking precise and universally accepted words for a number of issues which relate to sand, gravel, and crushed rock. A number of issues and new concepts that relate to sand, gravel and crushed rock may give rise to new lists of terminology for continued discussions such as:

- Common terms related to specific uses and sources that were not addressed in this discussion, including "construction sand", "proppant sand" and "black sand";
- Terms related to circular economy and relatively new alternative materials that are used as aggregates, including synthetic materials;
- Terms related to sand and new developments in the fields of "building with nature" and "nature-based solutions".

This list will set the agenda for UNEP/GRID-Geneva multi-stakeholder reviews in the coming years.

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