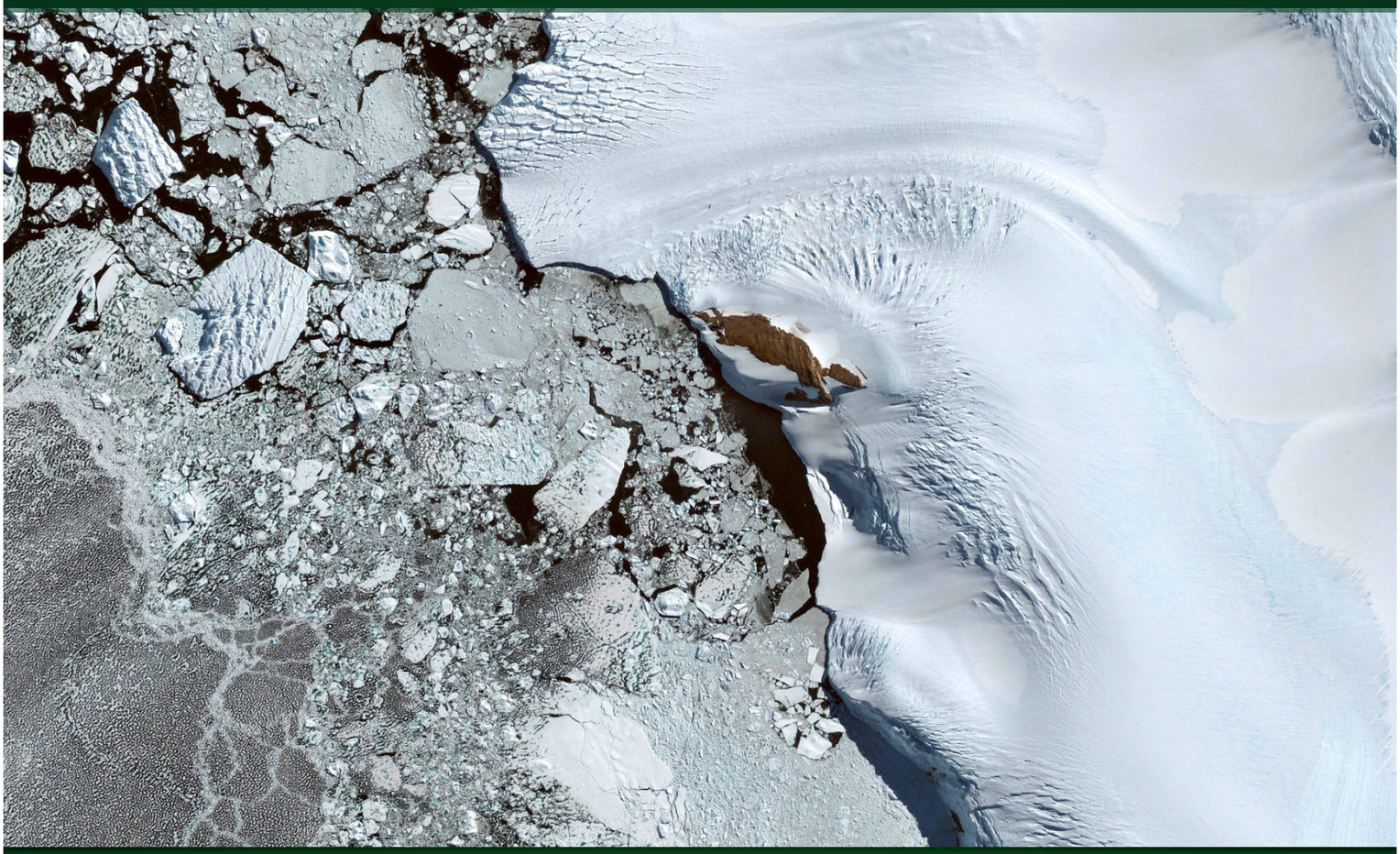
The ESG Risks & Impacts of Infrastructure Companies Classification Standard

TICCS+ Version 2.0



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1. Introduction

Why an ESG Impact and Risk Taxonomy?

In a recent industry survey (Blanc-Brude et al., 2022), we found that a majority of infrastructure investors require ESG (non-financial) data primarily to understand and manage risks. This takes precedence over reporting to regulators, which is their third main concern, except in Europe where it is their second main concern.

In a previous paper, we have argued the current demand for ESG data and reporting stems from two issues: 1/ a lack of knowledge regarding the ESG impacts and risks of infrastructure companies; and 2/ the fundamental uncertainty that the ESG aspects of their activity create for investors. Addressing the first issue amounts to documenting the exposure (or beta) of a company to certain risks.

Developing this proposed scientific body of ESG investment knowledge (or ontology) requires a number of key building blocks, which are:

1. The clearly stated aim to create knowledge that relates the ESG characteristics of **infrastructure companies** – the entities in that investors decide to buy or hold – to investment decisions made on financial grounds i.e. considerations of risk and reward;
2. This helps clarify that the impacts of interest are those of an infrastructure company and that the relevant risks are those to which the same company is exposed. Hence, the relevant **domain of knowledge**: instances of ESG risks and impacts of infrastructure companies. By grounding the approach in this manner, it becomes clearer that impacts are also sources of risks.
3. Next, a **classification system** is needed for the various objects of interest, including of course infrastructure companies and their ESG risks and impacts, but also standard classes of attributes and relationships that allow the ESG characteristics of infrastructure companies to be described and create this knowledge. The definition of the attributes and relationships that create this knowledge can then be science- and theory-based, using the most consistent assumptions or models in order to create a broad user base and maximise potential commitment by users.
4. Finally, this enables the question of **materiality** to be addressed. Materiality is a weak point in existing ESG schemes: they provide lists of potential material information to report or collect, but do not anchor this materiality in objective measures that would relate to the activities of infrastructure companies. Developing science-based materiality profiles for each of the 95 types of infrastructure assets captured in the industrial activity pillar of the TICCS® classification is a key step in the development of a body of ESG investment knowledge for infrastructure investment and the object of ongoing research at EDHECinfra.

Note that, to define infrastructure, we follow the TICCS® classification system of infrastructure companies, which puts the firm at the centre of the approach. Infrastructure companies are what equity investors buy and debt investors lend to. Hence our focus is the ESG impacts **of** an infrastructure company, and what ESG risks it is **exposed to**. It follows that any ESG reporting or scoring, while it may spring from asset-level data, can be evaluated at the firm level, which is the correct unit of account for an investment reporting scheme;

TRIICCS v2.0

A first version of The ESG Risks and Impacts of Infrastructure Companies Classification Standard

(TRIICCS) was published in an EDHECinfra research paper in 2021 (Manocha and Blanc-Brude, 2021). This document presents the updated 2023 update the classification system.

The objectives of the ESG taxonomy are to define:

- ESG classes that are always relevant to some extent to any infrastructure asset and service, so that, at the aggregate level, different infrastructure investments can be directly compared;
- ESG classes that can be described as a function of objective parameters, leaving no or little room for interpretation;
- A taxonomy that is not a laundry list but a dynamic classification system that can be expected to explain, in part, the market or social value of a given infrastructure investment on a relative basis. In other words, it helps to measure the relative exposure of individual infrastructure companies to ESG risk factors and determine the relationship between ESG and value.

TRIICCS is an exhaustive taxonomy of the impacts and risks that are relevant to infrastructure companies. At its most granular level, it identifies and classifies the environmental and social impacts and risks *material* of infrastructure companies and defines the principles of corporate governance that should guide the operations of these companies.

This taxonomy thus defines the boundaries of ESG applicable to the infrastructure asset class.

Alignment with ESG Regulations

TRIICCS has been designed to enable the alignment of identified impact and risk classes with various ESG standards, regulatory classifications, and reporting requirements.

For example, the work of the European Union's Sustainable Finance Disclosure Regulations (SFDR). SFDR requires "financial market participants and financial advisers (...) to disclose specific information regarding their approaches to the integration of sustainability risks and the consideration of adverse sustainability impacts" (SFDR, L317/2).While its primary public policy objective is to minimise adverse impacts on the environment and society, SFDR is also about the risks posed to financial asset values. It requires the disclosure of so-called sustainability risks that pose "an environmental, social or governance event or condition that, if it occurs, could cause an actual or a potential material negative impact on the value of the investment" (SFDR, L317/9). Finally, the description of what matters from an ESG standpoint is documented using Regulatory Technical Standards (RTS) establishing a framework of reporting on principal adverse impacts and risks. The ESG data required by the RTS describes detailed indicators for environmental and social impacts. To ensure compatibility with the SFDR, the EDHEC*infra* ESG taxonomy allows mapping of the required disclosures to respective impact and risk classes. Given that TRIICCS is an exhaustive list of ESG impacts and risks for the infrastructure sector, 100% of the mandatory disclosures can be (thematically) mapped to different sub-classes of this taxonomy.

The taxonomy thus serves as a meta-standard that allows the mapping of different reporting requirements and standards to one another and subsequently to individual impacts and risks material for infrastructure companies.

The rest of the document is structured as follows: We first present the concepts and principles used to build the taxonomy, then outline the structure of the taxonomy, present in detail the ESG classes relevant for infrastructure companies and finally outline the use-cases of the taxonomy.

2. Concepts and Principles Underlying the ESG Taxonomy

This chapter outlines the concepts and principles used to build the ESG taxonomy of impacts and risks.

2.1 Concepts

2.1.1 Double Materiality

The distinction between impacts and risks of infrastructure companies follows from the notion of double materiality.

An infrastructure company - as a result of its activities, processes, operations and policies - can have a positive or negative impact on the environment and society. In addition to this, an infrastructure company faces risks from external actors within the boundaries of the environment and society such as climate change, customers, communities, regulators etc.

There is a circularity in this dichotomy between risk and impact: certain impacts can, directly or indirectly, create or increase risks for the party causing them. This notion of impacts directly or indirectly creating risks is referred to as double materiality (figure 1). Therefore, the exposure of infrastructure assets to risks is also a function of the magnitude of impacts it has. For example, a port whose purpose is to facilitate the import and export of goods has significant Scope 3 emissions. In fact, the shipping industry contributes to about 10.6% of total transport emissions (Ritchie, 2020). These emissions cause a negative climate impact. In the new low carbon economy, the GHG emissions of ports expose them to multiple transition risks, such as a potential carbon tax, regulations that require ports to provide sustainable fuel for ships etc. Research (Chalmers and Basu, 2020) suggests that transition risks are particularly important for infrastructure assets, which face unexpected dynamics from regulatory, legal, market, technological and reputational risks.

2.1.2 Classification Theory

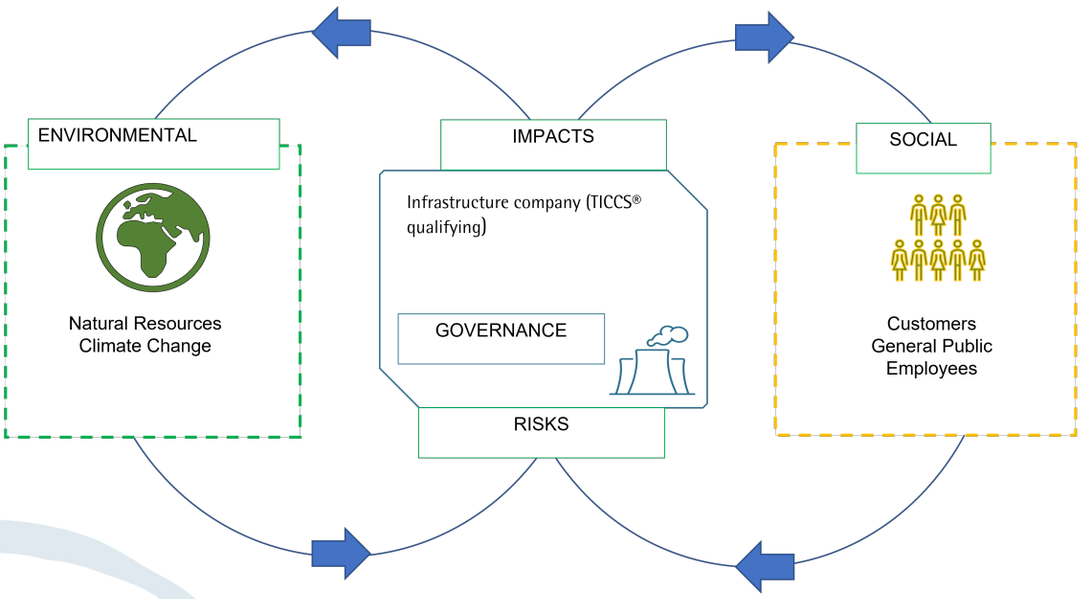
The ESG taxonomy is built following **classification theory** (Greenlaw and Liang, 2002), over three levels of a super-class (vertical), a class and a sub-class. The logic of classification theory requires that organising a domain of objects into classes must leave no two classes with any object in common; in addition, all of the classes together must contain all of the objects in the domain. Further, the principles or objectives used to classify a domain of objects depend upon the nature of the objects themselves. For example, in the environmental pillar, the vertical of *Nature* is made up of the classes of Biodiversity, Oceans and freshwater, Land, and Atmosphere.

We followed this logic strictly when building the taxonomy. The super-classes within each pillar collectively define the actors, giving a complete understanding of all the potential impacts or risks from the perspective of infrastructure companies.

Similarly, the classes of any given super-class were defined to be unique, with the objective of providing a comprehensive overview of the themes pertaining ESG impacts of risks, as were their nested sub-classes.

The classification was (where available) based on well-established theoretical frameworks and fundamental concepts or mechanisms. For instance, under environmental risks, the class of physical risk (acute and chronic) was classified into the sub-classes of temperature related risks,

Figure 1: Double materiality of ESG for infrastructure assets



wind related risks, water related risks and solid-mass related risk. This classification is the same as that followed by the Task Force on Climate Related Disclosures (TCFD, 2020). Classifying the physical risks in this manner ensures that they are unique and cover all possible types of events that can pose an environmental risk to infrastructure companies as well as being compatible with the international frameworks and taxonomies already widely adopted globally.

2.2 Principles

The taxonomy is built on the following principles:

- Salience: The classes outlined in the taxonomy are important to capture to understand and measure the ESG performance of infrastructure companies.
- Credibility: The classes outlined in the taxonomy are scientifically valid.
- Independence: The classes outlined in the taxonomy do not overlap with each other in scope.
- Measurability: The classes outlined in the taxonomy are realistic to qualify.
- Reliability: The classes outlined in the taxonomy will be consistently measurable over time.

3. Structure of the ESG Taxonomy

The taxonomy has three pillars, Environmental, Social and Governance, and two dimensions, Impacts and Risks. The distinction between the impacts and risks of infrastructure companies follows from the notion of double materiality. From the perspective of an infrastructure company, the impacts are outward facing i.e. they are a result of its activities, processes, operations and policies. Such impacts can be both positive and negative. By contrast, risks are inward facing i.e. they look to assess how external actors within the boundaries of the pillars can negatively influence the company's operations.

Within the pillars, the E and S pillar of the taxonomy comprise **verticals** on which the operations/activities of a company have an impact or from which they face a risk. Following the classification theory, these verticals collectively identity all the actors (who/what) that are impacted by or pose a risk to the infrastructure company within each pillar. For example, the social pillar has four verticals of General Public, Customers, Employees and Regulators i.e. an infrastructure company can have a social impact on or face a social risk from any of these. The next level of **classes** collectively identify the individual categories within each vertical that are relevant from an E or S perspective for infrastructure companies. For example, within the vertical E1: Nature, infrastructure companies can positively or negatively impact the classes of EI 1.1 Biodiversity, EI 1.2 Oceans and Freshwater, EI 1.3 Land and EI 1.4 Atmosphere.

The final level of the taxonomy, the **sub-classes** identifies the actual impacts and risks on/from any given class. For instance, an infrastructure company can impact the class of biodiversity (EI 1.1) in many ways. It could cause an 1.1.1 loss in biodiversity (cutting down trees for a greenfield project leads to habitat loss and subsequent loss of dependant species). Or it could cause an EI 1.1.2 impact - disturbing the biodiversity (noise associated with landing and take-off near airports can cause stress to local biodiversity and even affect their physiology). In contrast, it might also be responsible for an EI 1.1.3 event, restoring biodiversity of degraded ecosystems (for example, by carrying out programs to plant native trees along the sides of roads), or EI 1.1.4, conserving biodiversity by ensuring that the negative impacts are mitigated at source (such as building of wildlife crossings to connect the habitat on two sides of busy road). It could even result in EI 1.1.5, enhancing or improving the biodiversity of a region (e.g. building of wildlife crossings to connect the habitat on two sides of busy road).

In summary, the taxonomy classes for the environmental and social pillars have the following hierarchy:

- Level 1 : Super classes, also called the verticals. These are the actors (who/what) that have an impact on or pose a risk to the infrastructure company.
- Level 2: Classes. These are the individual categories of a super-class relevant from an environmental and social perspective. These can be understood as the different themes of impacts and risks of infrastructure companies within any given vertical.
- Level 3: Sub-classes: These are the actual impacts that an infrastructure company has on the parent class, or the actual risks that the infrastructure company faces from the parent class.

The governance pillar is simple structured as a set of corporate governance principles guiding how (infrastructure) companies should be managed.

4. Classes of the ESG Taxonomy

Environmental Pillar

Infrastructure companies invest in large, immobile capital assets that have little to no alternative use. Given their significant physical footprint, they typically impact important areas of land and require substantial amounts of materials and natural resources to build, operate and maintain, refurbish and decommission. Throughout their life-cycle, infrastructure assets thus impact all aspects of stock of natural capital, from biodiversity to water, land and the atmosphere.

Indeed, as the backbone of modern economic activity, the ultimate role of infrastructure is often to support the consumption of energy by economic agents engaged in activities that require considerable amounts of energy, the vast majority of which is currently sourced from fossil fuel (IEA 2020). Hence, most infrastructure contributes to a degree to green house gas emissions.

Infrastructure assets are also exposed to multiple environmental risks based on their location, design and activities. Their rigid and static nature implies that acute and chronic physical risks events can cause significant damage to assets. Physical hazards can render the infrastructure asset inoperable (flooded roads as a result of a severe precipitation event), cause damage to the asset (road damaged as a result of a landslide) or to the supporting infrastructure (damaged pipeline that supplies water to a coal power plant). Environmental degradation may also limit or prevent an infrastructure from functioning normally if certain natural resources became unavailable (e.g. water used as coolant in a power station).

Taken together, the classes of impacts and risks that make up the environmental pillar of the taxonomy are presented in table 1. The definitions of each of these is presented in the following sections.

E1 Nature

The Task Force on Nature-related Financial Disclosures (TNFD) understands nature, or the natural world, as the diversity of living organisms (including people) and their interactions among themselves and their environment. Nature can be understood through a construct of four realms – Land, Ocean, Freshwater and Atmosphere. In addition to this, TNFD considers biodiversity as a fundamental building block of nature (TNFD, 2022).

All infrastructure assets require construction, conduct specific activities and operations throughout their design life, require regular maintenance and, finally, undergo refurbishment or decommissioning. The super-class or vertical of nature considers the potential positive and negative impacts that the infrastructure company can have on an affected region by means of consuming, depleting, disturbing, polluting, conserving, restoring or protecting the four realms of nature.

The following are the impact classes of the super-class Nature:

EI 1.1 Biodiversity: The variability among living organisms from all sources, including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (United Nations, 1992).

Table 1: Environmental Pillar

E1	Nature	E2	Climate Change
	IMPACTS		
EI 1.1	Biodiversity	EI 2.1	Greenhouse gases
EI1.1.1	Loss	EI 2.1.1	GHG Emissions
EI1.1.2	Disturbance	EI 2.1.2	GHG Avoidance
EI1.1.3	Restoration	EI 2.1.3	GHG Removal
EI1.1.4	Conservation		
EI1.1.5	Enhancement		
EI 1.2	Oceans and freshwater		
EI 1.2.1	Pollution		
EI 1.2.2	Depletion		
EI 1.2.3	Diversion		
EI 1.2.4	Preservation and protection		
EI 1.2.5	Restoration		
EI 1.3	Land		
EI 1.3.1	Pollution		
EI 1.3.2	Change in land use		
EI 1.3.3	Degradation		
EI 1.3.4	Preservation and protection		
EI 1.3.5	Restoration		
EI 1.4	Atmosphere		
EI 1.4.1	Air pollution		
EI 1.4.2	Air quality improvement		
	RISKS		
ER 1.1	Resource loss risks	ER 2.1	Physical risks (acute and chronic)
ER 1.1.1	Quality risks	ER 2.1.1	Temperature related risks
ER 1.1.2	Availability risks	ER 2.1.2	Wind related risks
ER 1.2	Physical risk-ex climate change	ER 2.1.3	Water related risks
ER 1.2.1	Solid-mass related risks	ER 2.1.4	Solid-mass related risks
ER 1.2.2	Water related risks		

Throughout their life cycle, infrastructure assets can have a negative impact on the local biodiversity of a region by destroying habitats and disturbing local ecosystems. To mitigate these impacts, infrastructure companies may conserve, enhance or restore degraded ecosystems.

EI 1.1.1 Loss: Biodiversity loss is the decline in the number, genetic variability, variety of species, and the biological communities in a given area. It is inclusive of extinction of species. This loss in the variety of life can lead to a breakdown in the functioning of the ecosystem where decline has happened. Drivers of biodiversity loss are pollution, invasive species, habitat destruction, over-exploitation and climate change etc.

Infrastructure, such as roads when built in forested areas, alter ecological conditions by cutting through natural habitats and consequently reduce populations of many wildlife species dependent on this ecosystem. Damnsmay divert water away from habitats, significantly reducing the marine species in the impacted water body. A change in the species can lead to an imbalance in the food chain, causing a breakdown of the ecosystem.

EI 1.1.2 Disturbance: In ecology, a disturbance is a temporary and localised change in environmental conditions that causes a pronounced change in an ecosystem. A disturbance can also occur over a long period of time and can impact the biodiversity within an ecosystem. Ecological disturbance can, thus, be defined as an event that causes temporary and localised shifts in demographic rates of the associated biodiversity (Dornelas, 2010).

Infrastructure activities can cause a disturbance in the local ecosystem. For example, noise from the construction of infrastructure in general, or operations of transport infra such as airports, roads and trains, can have physiological and behavioural effects on wildlife. Noise pollution makes it difficult for animals to use sound for navigation, finding food, mating, and avoiding predators, affecting many animals' ability to survive (Newport et al., 2014).

EI 1.1.3 Restoration: Degraded ecosystems are often missing species, groups of species or even whole functional groups, such as top-level predators. Biodiversity restoration is the process of assisting in the recovery of habitats that have been degraded, damaged, or destroyed; it focuses on establishing the ecological processes necessary to make terrestrial and aquatic ecosystems sustainable, resilient, and healthy under current and future conditions. Infrastructure companies can carry out or fund activities such as reforestation, coral rehabilitation, re-introduction of native plant and animal species to an ecosystem etc. For example, in 2018, Sydney Airport partnered with Conservation Volunteers Australia to revive a critical wildlife habitat area called the Rockdale Wetlands, close to a Sydney suburb (ATAG, 2018).

EI 1.1.4 Conservation: Biodiversity conservation, the practice of protecting and preserving the wealth and variety of the biodiversity and maintaining the function of the natural ecosystems of a given region. Infrastructure companies can contribute to environmental conservation by avoiding, minimising and mitigating impacts from construction and operational activities, or by implementing biodiversity management plans. Wildlife crossings are also an example of infrastructure that enables habitat conservation by connecting habitats and combating habitat fragmentation.

EI 1.1.5 Enhancement: Biodiversity enhancement is the process of improving the organisms and habitats of a given region and increasing the biodiversity of a given area. For example, offshore wind farms can create refuges for benthic habitats, fish and marine mammals, giving life to a new ecosystem (Bennun et al., 2021).

EI 1.2 Oceans and freshwater Water resources are natural sources of water that are useful for human activities. These include surface water, ground water and frozen water. In this case, the water resources referred to are those that the infrastructure company withdraws water from, discharges water to or those that are in the vicinity of the asset.

EI 1.2.1 Pollution: Water pollution occurs when harmful substances or contaminants (above a given concentration or pollutant load) are discharged or leached into water resources causing the degradation of the water quality of the given resource. For example, the Southern Water, a UK utility company, deliberately spilled sewage 6,971 times in water bodies in Hampshire, Kent and West Sussex between 2010 and 2015. In addition to making the water unsuitable for human activities, water pollution can have adverse impacts on marine and aquatic life.

EI 1.2.2 Depletion: Resource depletion is the consumption of a resource faster than it can be replenished. In this case it refers to depletion of water resources linked with excessive consumption and extraction. A classic example is pumping out of ground water by water utilities without giving the water tables adequate time to recharge and replenish.

EI 1.2.3 Diversion: Diversion refers to the mass movement of water, temporarily or permanently, which can cause a significant changes in the flow and water levels in a given water body. Water diversion projects are typically undertaken for building hydroelectric power generation, fortifying national/regional water supply and flood control.

EI 1.2.4 Preservation and protection: Preservation of water resources includes all policies, strategies and activities (such as optimally managing the quantity of water intake for power plants) to protect the quality, quantity and integrity of water resources.

EI 1.2.5 Restoration: Restoring the quality, quantity and integrity of the water bodies that have been subject to pollution or depletion,

such as cleaning up of rivers in case of accidental/deliberate discharge of sewage by sewage treatment facilities.

EI 1.3 Land: Land resources refers to the geographic land (soil) and all the naturally occurring resources such as rocks, minerals and ores present under the surface of the land.

EI 1.3.1 Pollution: Land pollution, the deposition of solid or liquid waste materials on land or underground in a manner that can contaminate the soil. For example, heavy metals accumulation in soils under the application of sewage sludge and effluent from wastewater treatment plants is a major environmental concern (Behbahaninia et al., 2010).

EI 1.3.2 Change in land use: Land use change involves human induced transforming of the landscape of a piece of land so it can be used for another purpose, as done in greenfield developments.

EI 1.3.3 Degradation: Land degradation is the reduction in the quality of soils and land utility. It negatively affects food production, livelihoods, and the production and provision of other ecosystem goods and services. Desertification is a form of land degradation by which fertile land becomes desert (WHO, 0220). In this case it refers to degradation of land resources of soil, rocks, minerals, ores etc. used by the infrastructure company. Research has found that over the years construction of roads and rail infrastructure is one of the main causes of land degradation (European Commission, 2019).

EI 1.3.4 Preservation and protection: Preservation of land resources includes all policies, strategies and activities to protect the quality, quantity and integrity of the soil and the resources under its surface, such as rocks, minerals and ores. Infrastructure assets such as wind farms can be sited along fence rows or property lines to prevent disturbance to farmland.

EI 1.3.5 Restoration: The process of restoring the quality, quantity and integrity of the soil and the resources such as rocks, minerals and ores present under the surface of the land that have been subject to pollution or degradation. For example, when laying down or maintaining pipelines for utility networks, companies can take actions that restore the soil to baseline quality. One way this is done is by segregating soil during digging and restoring the soil back to its original depth to ensure that the nutrients and hydrological gradients are not adversely impacted.

EI 1.4 Atmosphere: The atmosphere is a blanket of gases that surrounds the earth. It contains the air we breathe, protects the planet form harmful radiation, maintains the global water cycle and regulates global temperatures and the global climate.

EI 1.4.1 Air pollution: Air pollution occurs in many forms but can generally be defined as gaseous and particulate contaminants that are present in the earth's atmosphere. Sources of air pollution include the emission of pollutants into the air by infrastructure. Infrastructure assets such as waste water treatment plants are associated with emitting volatile organic compounds, carcinogens, carbon monoxide, ammonia, hydrogen sulphide and particulate matter (Widiana et al., 2019)

EI1.4.2 Air quality improvement: Reducing the concentration of contaminants emitted from the activities of infrastructure assets, so as to maintain the pollutants below levels considered to safe for biodiversity and public health.

The following are the risk classes of the super-class Nature:

ER 1.1 Resource loss risk: Access to natural resources can be understood as the opportunity

and the ability to make use of the natural resources required for the activities of the infrastructure company.

The degradation (loss of quality) or depletion (loss of quantity) of natural resources can occur due to various activities of the infrastructure company posing a risk to the operations of the company dependent on these resources. For example, the overuse of water can lead to water stress posing a risk to nuclear power plants that require large volumes of cooling water.

ER 1.1.1 Quality risk: The deterioration of quality of natural resources in a given geographic region, associated with activities of infrastructure companies such as pollution. For example, an accidental radioactive contamination of a water body by a nuclear power plant can pose a risk to the operations of water utilities using that water body as a source of their water supply.

ER 1.1.2 Availability risk: The depletion in the stock of a natural resource in a given geographic region, associated with human activities such as over-consumption. Following the same example as above, in the case of a depleted water source, nuclear power plants may have to source water from a distance. This also poses operational risks to the plant as it may have to temporarily reduce operations in the event of water unavailability.

ER 1.2 Physical Risk-ex climate change: The class of physical risks looks at the risks that infrastructure assets face from physical events that are not exacerbated by climate change.

Physical events can render an infrastructure asset inoperable (volcanic ash reducing visibility and this making an airport temporarily unusable), cause physical damage to the asset (road damaged as a result of subsidence) or to the supporting infrastructure (damaged pipeline that supplies water to a coal power plant).

ER 1.2.1 Solid-mass related risks The risk resulting from the displacement of the physical movement of the earth i.e. siesimic risk. The risks from volcanoes, earthquakes and subsidence (from ground water pumping and compacting of soil) fall under this category.

ER 1.2.2 Water related risks The physical risk resulting from too much or too little water at any given location. The risks from tsunamis fall under this category.

The following are the impact classes of the super-class of climate change:

E2 Climate change:

Climate change can be understood as the abnormal variations in the expected patterns of the average weather of the Earth at a local, regional and global level. It is caused by an increasing concentration of greenhouse gases in the Earth's atmosphere. The taxonomy refers to climate change induced by anthropogenic activities such as the use of non-renewable energy sources.

EI 2.1 Greenhouse Gases A greenhouse gas is a gas that absorbs and emits radiant energy within the thermal infrared range, causing the greenhouse effect and leading to global warming. The primary greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, ozone and synthetic fluorinated gases such as CFCs, HFCs and HCFCs.

Infrastructure is key in contributing to the global GHG emissions. The transport infrastructure accounts for around 21% of global carbon dioxide (CO2) emissions of which road transport is responsible for about three quarters of emissions. Rail travel and freight emits only 1% of transport emissions. Other transport – which is mainly the movement of materials such as water, oil, and gas via pipelines, is responsible for 2.2%.Aviation accounts for 11.6% of transport emissions, while shipping contributes

about 10.6% of total transport emissions (Ritchie, 2020).

EI 2.1.1 GHG Emissions Emissions of greenhouse gases leading to an increase in their atmospheric concentration, measured in the units of parts per million (ppm) associated with the activities of an infrastructure company.

EI 2.1.2 GHG Avoidance Emission avoidance is the prevention of emitting carbon in the first place and can be divided into two categories, avoidance via carbon offsets and avoidance via direct carbon reduction measures such as efficinecy improvement.

EI 2.1.3 GHG Removal The removal of GHG's after they have entered the atmosphere from measures such as carbon capture and storage.

The following are the impact classes of the super-class of climate change:

ER 2.1 Physical risk(acute and chronic): The class of physical risks looks at the threat that infrastructure assets face from natural hazards. In this section we focus on climate-related hazards only.

Physical hazards can render the infrastructure asset inoperable (flooded roads as a result of a severe precipitation event), cause damage to the asset (road damaged as a result of a landslide) or to the supporting infrastructure (damaged pipeline that supplies water to a coal power plant). In addition to this, physical events can alter the availability and quality of natural resources required as inputs for the activities of infrastructure companies.

The classification adopted by this taxonomy follows the classification of climate-related hazards used by the Task Force on Climate Related Disclosures (TCFD, 2020) and the EU Taxonomy (TEG, 2020) .

ER 2.1.1 Temperature related risks: Natural hazard resulting from changes in the global/regional/local temperatures. Examples of chronic temperature related risks include:

- Changing temperature (air, freshwater, marine water)
- Heat stress
- Temperature variability

Examples of acute temperature related risks include:

- Heat waves
- Cold wave/frost
- Wildfire

Infrastructure assets are very susceptible to changes in temperature. A change in temperature can cause physical damage to the infrastructure assets, such as the buckling of roads and rails, softening of paved surfaces such as roads and runways or pose operational risks to infrastructure assets. For example, as temperatures rise and increase the temperature of water bodies, the efficiency of nuclear plants drops as the water cannot be used to cool their reactors efficiently.

ER 2.1.2 Wind related risks: Natural hazards resulting either from high wind events or from changes in the average global, regional or local wind patterns.

Examples of chronic wind related risks are changing wind patterns. Examples of acute wind related risks include:

- Cyclones, hurricanes, typhoons
- Storms (blizzards, dust, sand)
- Tornadoes

Wind storms, hurricanes, tornadoes and changing wind patterns can pose risks of physical damage (wind events causing damage to port crane infrastructure, blade damage or tower collapse of wind turbines during tornadoes) or cause opera-

tional risks to infrastructure assets (for example loading unloading operations have to be stopped in high winds to prevent the damage to crane equipment and cargo; airports have to suspend landing and takeoffs in high wind events for safety reasons).

ER 2.1.3 Water related risks: The physical risk resulting from too much or too little water at any given location. Examples of chronic water related risks include:

- Changing precipitation patterns
- Precipitation or hydrological variability
- Ocean acidification
- Saline intrusion
- Sea level rise
- Water stress

Examples of acute water related risks include:

- Drought
- Heavy precipitation
- Flooding (coastal, fluvial, pluvial, groundwater)
- Glacial lake outburst

Flooding risks are material to almost all types of infrastructure assets. Floods may cause structural damage to assets (causing scouring on foundations of bridges, damaging electrical components or multiple types of infra assets etc) or cause or cause temporary disruption such as that to transport networks in flooding events.

ER 2.1.4 Solid mass related risk: The physical risk resulting from the displacement or the physical movement of earth. Examples of chronic solid mass related risks include:

- Coastal erosion
- Soil degradation
- Soil erosion
- Solifluction

Examples of acute solid mass related risks include:

- Avalanche
- landslide
- Subsidence

Infrastructure assets along the coastline are at a constant risk of erosion causing a damage to the foundation of the asset which can compromise its structural integrity. Avalanches and landslides, in addition to causing damage to the assets in their paths, can also block roads causing operational risks. Subsidence is also a very material risk for multiple types of infrastructure assets as it can cause very serious structural damage to roads, railways, bridges, airports etc.

SOCIAL PILLAR

Infrastructure is created to provide specific services to end users, most of whom tend to be the general public as well as public and private sector organisations. Services such as access to electricity, transport or telecommunication provide direct benefits to end users and the utility directly derived from consuming infrastructure services is private and does not constitute a form of social impact. For instance, roads provide a service for individuals and firms to move people and goods from one point in space to another. Electricity companies provide households and firms with power to operate electrical devices. Such strictly private consumption does not qualify as social impact.

However, because they often provide essential services, the activities of infrastructure companies also have significant social impacts on individuals, households, the economy and society. The social impact on the general public can be of two types: Economic Development and Human Wellbeing. The former refers to the social (indirect) impact of infrastructure services on *individuals*, while the later refers to social impacts on the *collective*. Infrastructure companies and services enable economic development impacts by impacting the value of adjacent land, real estate and enabling businesses and other

infrastructures. For example, beyond the strict consumption of transport services, mobility creates valuable real options for individuals who can - for example - work, study or receive medical treatment as a result.

Infrastructure companies can have a range of impacts on the collective welfare of the general public such as infringing on or protecting human rights, impacting the health conditions of the public, disturbing or improving the quality of life of society (e.g. by creating or avoiding congestion), and the preservation, promotion or degradation of heritage and culture.

The regulator is an important social actor for the infrastructure asset class. In infrastructure investment, the government specifies in the concession different public service constraints (pricing structure, safety and environmental regulations). The intervention of the government rests on different arguments: the existence of externalities, natural monopolies, public goods and imperfections on the capital market (Debande, 1999).Thus building of infrastructure (national, regional and local) requires long-term support of the regulator and timely regulator engagement.

The above discussed the manner in which infrastructure can have an impact on the social super-classes. Next, we discuss how infrastructure companies are also exposed to social risks of two types: social acceptability risks and risks to workforce availability.

Social acceptability is a central issue when investing in private infrastructure companies. As indicated above, infrastructure assets have a significant environmental footprint and can lead to significant disruption for surrounding populations that may nor always be the direct beneficiaries of the construction of these assets (e.g. dams, high-voltage power transmission, etc.). The for-profit private operation of infrastructure companies is also highly controversial in a number of countries. There is a documented regulatory pendulum effect by which different countries go from periods of supporting private infrastructure ownership to opposite periods of widespread nationalisations, followed by new waves of privatisations (see Blanc-Brude, 2013, for a discussion and literature review).

The social acceptability risk of infrastructure companies is split between the perception of its customers, including in terms of service quality, affordability and accessibility, that of the general public especially the reputation of the sector and of the firm, as well as sentiments surrounding privatisation.

Workforce availability is another class of social risk for infrastructure companies. While operating infrastructure assets is usually not a labour-intensive activity, their construction and maintenance phases can be. Some infrastructure companies such as ports or utilities employ numerous staff exposing them to the risk of industrial action from unions as well as issues with availability of skilled labour required for specific purposes (such as needing certified crane operators in ports).

Finally, regulators can pose a risk to the operations of infrastructure companies. for example by updating or implementing new legislation, such as a carbon tax to support alignment with a low carbon future. Regulatory intervention in the case of poor performance or poor acceptability of specific companies of sectors can pose the risk of of fines, nationalisation (where applicable) and business closure.

Taken together, the classes of impacts and risks that make up the social pillar of the taxonomy are presented in table 2 and table 3. The definitions of each of these is presented in the following sections.

The following are the impact classes of the super-class of general public:

Table 2: Social Pillar (Table 1 of 2)

S1	General public	S2	Customers
	IMPACTS		
SI 1.1	Collective welfare	SI 2.1	Consumer interests
SI1.1.1	Human Rights (ex labor rights)	SI2.1.1	Quality of service
SI1.1.2	Public health and safety	SI2.1.2	Affordability of service
SI1.1.3	Public disturbance	SI2.1.3	Accessibility of service
SI1.1.4	Heritage and culture	SI2.1.4	Customer health and safety
SI 1.2	Human development		
SI1.2.1	Standard of living		
SI1.2.2	Human capital		
SI1.2.3	Healthy life		
SI 1.3	Asset values		
SI1.3.1	Related land value		
SI1.3.2	Related real estate value		
SI1.3.3	Related business value		
SI1.3.4	Related infrastructure asset value		
	RISKS		
SR 1.1	Social acceptability-public	SR2.1	Social acceptability-customers
SR1.1.1	Sector reputation	SR2.1.1	Perception of quality of service
SR1.1.2	Private ownership perception	SR2.1.2	Perception of affordability of service
SR1.1.3	Company reputation	SR2.1.3	Perception of accessibility of service
SR1.1.4	Climate change perception		

Table 3: Social Pillar (Table 2 of 2)

S3	Employees	S4	Regulators
	IMPACTS		
SI 3.1	Employee well-being	SI 4.1	Regulator engagement
SI3.1.1	Workforce health and safety	SI4.1.1	Political contributions
SI3.1.2	Working conditions	SI4.1.2	Lobbying
SI3.1.3	Benefits	SI4.1.3	Litigation
SI3.1.4	Labor rights		
	RISKS		
SR 3.1	Workforce availability	SR4.1	Regulatory risk
SR3.1.1	Strikes and slowdowns	SR4.1.1	Climate-related (transition risk)
SR3.1.2	Skill drought	SR4.1.2	Not climate related

S1 General public

General public refers to the individuals in a given population that in this case are (positively or negatively) impacted by the activities of an infrastructure asset. Impacts could be a function of proximity to an operating asset (individual living near roads and airports are exposed to noise and air pollution from the assets, individual exposed to water a water supply contaminated by discharged from a sewage treatment plant), connectivity because of an asset (highways connecting small towns to cities enabling commute to urban workplaces and providing access to education and healthcare) or location (resettlement required when building dams).

SI 1.1 Collective welfare The class of collective welfare refers to the positive and negative impacts of infrastructure companies on the well-being of a given community, where well-being can be understood as a state of health, happiness and/or prosperity.

SI 1.1.1 Human rights: As per the universal declaration of human rights (UN, 1948), human rights are rights inherent to all human beings, regardless of race, sex, nationality, ethnicity, language, religion, or any other status. Human rights include the right to life and liberty, freedom from slavery and torture, freedom of opinion and expression, the right to work and education, and many more. Everyone is entitled to these rights, without discrimination. Note that this sub-class does not consider labour rights together with human rights but rather looks at human rights under the vertical of "Employees". Resettlement programmes associated with the construction of infrastructure is riddled with controversies of human rights infringement (Hay et al., 2019; Fratkin, 2014; Morvaridi, 2004).

SI 1.1.2 Public health and safety: Public Health and Safety is generally defined as the science of the anticipation, recognition, evaluation and control of hazards that could impair the health and wellbeing of the public, taking into account the possible impact on the surrounding communities and the general environment (Alli, 2008). The operations of infrastructure assets can cause air pollution, water pollution, sound from wind turbines and data centres, vibrations from rail infrastructure all of which can have negative heath impacts on the public.

SI 1.1.3 Public disturbance: A public disturbance is a state in which the comfort or peace of members of the public is disrupted, without having a negative health impact. Activities of infrastructure assets, such as noise from roads or light from airport runways, can be a source of nuisance to the public.

SI 1.1.4 Heritage and culture: The heritage and culture of a community/society is the legacy of physical artefacts and intangible attributes of the community including but not limited to historic and cultural resources and archaeological remains (UNESCO, 2017). Wind farms are often under fire for negatively impacting the cultural heritage and landscape of the given site (Morvaridi, 2004; Silva and Delicado, 2017).

SI 1.2 Human development: The United Nations Development Programme defines human development as the process of enlarging people's choices, wherein the said choices allow them to lead a long and healthy life, to be educated, to enjoy a decent standard of living, as well as political freedom, other guaranteed human rights and various ingredients of self-respect (UNDP in Ghana, 1997, p 15). Infrastructure assets by providing access to basic human rights and enabling socio-economic development is usually associated with positive human development.

SI 1.2.1 Standard of living: Standard of living refers to the level of wealth, comfort, material goods, and necessities available to a certain socio-economic class or geographic area. The role of infrastructure in promoting socio-economic development and improving the standard of living of impacted communities is well documented, from improving education outcomes, enabling the flow of goods and services to markets and protecting populations from natural hazards (see amongst others Günther and Fink, 2011; Barrett et al., 2019; Ismail and Mahyideen, 2015; Garschagen et al., 2016; Donaldson, 2018; Banerjee et al., 2012; Duflo et al., 2015).

SI 1.2.2 Human Capital: Human capital is the stock of habits, knowledge, social and personality attributes (including creativity) embodied in the ability to perform labour so as to produce economic value (Goldin, 2016). Social infrastructure such as schools, colleges, universities and vocational institutes improve the human capital.

SI 1.2.3 Healthy life: A healthy life refers to a long life, free from diseases and acute and chronic health conditions. It stems from the environment and from the practices of population groups that are consistent with supporting, improving, maintaining and/or enhancing health. Infrastructure assets by improving efficiency of their activities, using better technology etc. can reduce the pollution associated with their activities. In addition to this infrastructure such as roads provide access to hospitals and clinics (social infrastructure) that are vital in keeping a community healthy.

SI 1.3 Assets Values: Asset value can be understood as the market value of all assets that can be impacted by infrastructure. Increased asset values translates to wealthier communities.

SI 1.3.1 Related land value: Land value is the market value of a piece of property including both the market value of the land

itself as well as any improvements that have been made to it. Land market values are highly sensitive to infrastructure investment and urban economic growth. Public works projects such as road construction, water supply, and mass transit investment produce benefits that are immediately capitalised into surrounding land values (Peterson, 2008). Conversly, damage to land (such as pollution) can negatively impact land values.

SI 1.3.2 Related real estate value: Property value refers to the market value of a piece of real estate based on the price that a buyer and seller agree upon. Just as with land market value, the availability of infrastructure assets and economic growth leads to a rise in real estate market value given the increased levels of accessibility and connectivity associated with the piece of real estate. For example, the construction of transport infrastructure typically leads to a price increase in surrounding neighbourhoods (Liang et al., 2021).

SI 1.3.3 Related business value: Business value is defined as the entire market value of the business, that is, the total sum of all tangible and intangible elements. Examples of tangible elements include monetary assets, stockholder equity, fixtures, and utility. Examples of intangible elements include brand recognition, good will, public benefit, and trademarks. This sub-class refers to the value of a business that excludes the market value of any real estate associated with the company. Infrastructure services enable business processes, thereby having a positive impact on related businesses' market value.

SI 1.3.4 Related infrastructure asset value: The market value of any given infrastructure asset is dependent (positevely and negatively) on multiple factors, one of which is the availability of infrastructure networks connected physically or digitally. This network effect, increases the market value or utility a user derives from a good or service (infrastructure in this case) and leads to an increase in related infrastructure market value. For example roads enable easy access to multiple other types of infrastructure, such as airports, train stations, hospitals, schools etc., potentially increasing their utility and usage.

The following are the risk classes of the super-class of general public:

SR 1.1 Social acceptability - public: Social acceptability is the outcome of a collective judgement or collective opinion of a project or company. The collective judgement may be positive or negative and is never set in time. It is made up of what people feel about a company, based on their experience, what they have heard/read about the company, or available facts about the company.

General public refers to the individuals in a given population. Negative perceptions of an infrastructure company by the general public can manifest in the form of political risk, ultimately leading to the imposition of regulatory constraints which undermine the usefulness and usability of the infrastructure assets.

SR 1.1.1 Sector reputation: Sector reputation refers to the social acceptance of a whole infrastructure sector by the general public and is not related to a specific infrastructure asset or the actions of a particular infrastructure company. For example, the social acceptability of the nuclear power varies greatly from country to country mainly due to safety concerns associated with nuclear power. Thus investing a nuclear projects in countries may be risky as protests may delay or even lead to cancellation of these projects (see Barkan (1979)).

SR 1.1.2 Private ownership perception: The social acceptance of privately owned infrastructure by the general public is referred to as private ownership perception. In many countries privately owned infrastructure, especially infrastructure that that provides basic services (healthcare, water etc.) is controversial.

SR 1.1.3 Company reputation: Reputation is the overall estimation in which an organisation is held by its internal and external stakeholders. Reputational risk comes from negative publicity, negative public perception or specific events, practices, process or actions of an infrastructure company such as ethics violations (human right violations of the labour force), safety and security issues (poor storage of flammable or toxic substances at ports), a lack of sustainability (emitting significantly more carbon-di-oxide than then sector average), poor quality (road full of potholes). A poor reputation can adversely impact a company's revenue, increase operating, capital and regulatory costs, or destroy shareholder value (Heery and Noon, 2008).

SR 1.1.4 Climate change perception: Public opinion on climate change is the aggregate of attitudes or beliefs held by a population concerning issues relating to "anthropogenic climate change, perceptions of climate change risks, concern about its seriousness, and thoughts on what, if anything, should be done to address it (Shwom et al., 2015).

The following are the impact classes of the super-class of customers:

S2 Customers:

Customers are defined as the group of individuals that use the service provided by the infrastructure company.

SI 2.1 Consumer interest: The provision of quality and reliability of the goods and services provided by a company (Morgera, 2011).

SI 2.1.1 Quality of service: Quality of service is the description or measurement of the overall performance of a service. Infrastructure companies by maintaining the quality of their service can have a positive impact on its users and can lead to customer satisfaction and customer delight (Desiyanti et al., 2018). Good quality of service can lead to favoured usage of any given asset, positively impacting its revenue. For example, research suggests that overall airport service quality is significantly related to airport reuse and destination revisit (Prentice and Kadan, 2019).

SI 2.1.2 Affordability of service: Affordability can be understood as the ability of a large proportion of society (including at least the top of the bottom quartile) to pay for a service. Un-affordable services, especially basic services like energy, water and health care, can cause stress and anxiety in customer. (especially for customers in the low income group) as it can negatively impact their quality of life. In the case of transport infrastructure, this can include expensive toll roads. Conversely, affordable infrastructure services can play a key role in the development of communities (Banerjee et al., 2008).

SI 2.1.3 Accessibility of service: Accessibility is the degree to which a service is available and physically accessible to as many users as possible. The positive impact associated with infrastructure services (energy, clean water, transportation networks, education, health-care etc.) will only materialise if the user has the ability to physically access the service. For example, the presence of electricity distribution networks is meaningless if there is no infrastructure to bring electricity to individual houses in a given location. Similarly, if a town along the highway does not have a slip road connecting the town to the highway, the residents or potential customers cannot capitalise on any socio-economic benefits offers by that infrastructure company.

SI 2.1.4 Customer health and safety: Provision of services to customers in a manner that is safe and does not pose a health risk to consumers during the life cycle of the asset (providing the service). For example, provision of water of good quality, free from impurities, contaminants and pollutants, can have prevent

adverse health impacts on the customers of water utilities.

The following are the risk classes of the super-class of customers:

SR 2.1 Social acceptability- customers: Social acceptability is the outcome of a collective judgement or collective opinion of a project or company. The collective judgement may be positive or negative and is never set in time. It is made up of what people feel about a company, based on their experience, what they have heard/read about the company, or available facts.

Customer dissatisfaction with the services offered by the infrastructure company can undermine the usefulness and usability of the asset in the long term and even lead to regulatory interventions in extreme cases.

SR 2.1.1 Perception of quality of service: Quality of service is the description or measurement of the overall performance of a service particularly the performance as perceived by users. In the context of social acceptability, a company perceived to providing poor quality of service can result in decreased usage of the asset and negatively impact the revenue of the company, poor acceptability may also lead to decreased investments in (other) assets owned/managed by the company or in some cases lead to monitoring by authorities and subsequent interventions such as fines.

SR 2.1.2 Perception of affordability of service: The perception of a service being affordable to a large proportion of society (at least the top of the bottom quartile). The perception of affordability by the customer base can contribute to poor social acceptability of infrastructure assets leading to reduced usability (for example tolls roads being under-used due to very high toll rates see Maulana (2019)) and even regulatory interventions (such as government acquiring highways to change toll structure, see Hassan (2019)). It can also impede/promote investments into certain types of infrastructure classes. For example, as the production cost of renewable energy falls, it translates to renewable energy becoming more affordable and socially acceptable for a large part of society and thus becoming an attractive asset class for investors (WEF, 2021).

SR 2.1.3 Perception of accessibility of service: The perception of a service being available and physically accessible to as many users as possible. The perception of a lack of accessibility can lead to reduced social acceptability of a company. It can consequently pose multiple types of risks such as the reputational risks associated with discriminatory behaviour (in cases where public transport infrastructure cannot be used by disabled, handicapped or at-risk personnel due to unavailability of lifts and ramps). A lack of accessibility also inevitably translates to less usability of an asset (for example trains stations and airports with better connectivity are preferred by customer), impacting its revenues.

The following are the impact classes of the super-class of employees:

S3 Employees

The individuals on the payroll of the company.

SI 3.1 Employee wellbeing: Employee wellbeing refers to the state of employees' health, happiness and/or prosperity.

SI 3.1.1. Workforce health and safety: Workforce Health and Safety is generally defined as the science of the anticipation, recognition, evaluation and control of hazards arising in or from the workplace that could impair the health and wellbeing of the workforce (Alli, 2008). By ensuring HSE protocols, strategies, policies and programmes are established, updated and enforced, infrastructure companies can reduce

the exposure of employees to workplace risks, having a positive impact on their wellbeing. This is especially true in high-risk industries such as ports where employees work with heavy machinery, dangerous goods, chemical agents etc (TFT Pneumatic, 2021).

SI 3.1.2 Working conditions: The International Labor Organization (ILO) describes working conditions to encompass a broad range of topics and issues, from working time (hours of work, rest periods, and work schedules) as well as the physical conditions and mental demands that exist in the workplace (ILO, 2022). Infrastructure companie, can ensure that working conditions adhere to international best practices so as to reduce the negative impacts associated with workplace demands on the well-being of employees. For example, port companies can schedule workers in shifts to avoid fatigue in workers. Fatigue means a state that can be caused by many factors such as long hours, shift work, or inadequate rest which will result in a decline in alertness and performance, stemming from the likes of slowed movements and reactions (TFT Pneumatic, 2021).

SI 3.1.3 Benefits: Non-wage compensation provided to employees. The most common benefits are medical, disability, and life insurance; retirement benefits; paid time off; and fringe benefits (U.S. Bureau of Labor Statistics Division of Information Services, 2020). Better benefits generally lead to happier, more productive and loyal employees.

SI 3.1.4 Labour rights: The ILO declaration on fundamental principles and rights at work (Organization, 1998) requires infrastructure companies to commit to uphold both the legal rights (such as meeting minimum wage, eliminating discrimination at work) and human rights (for example, eradicating the use child and forced labour in construction and operations of assets) of the labour force. In general, these rights influence working conditions the most prominent of which is the right to freedom of association. Infrastructure companies by allowing unions and giving labour the collective bargaining power.

The following are the risk classes of the super-class of employees:

SR 3.1 Workforce availability: Workforce availability is defined as the availability of enough personnel to carry out all the activities of an infrastructure company.

SR 3.1.1 Strikes and slowdowns: Labour strikes, simply called strikes, are the mass refusal of employees to work, usually in response to employee grievances, and they can disrupt the daily operations of a company. A slowdown is an industrial action in which employees perform their duties but seek to reduce productivity or efficiency in their performance of these duties. Strikes and slowdown can pose an operation and revenue risk to assets. In Paris, for example, recent strikes by airport staff led to cancellation of one in five flights (Laurent, 2022), and a strike by train drivers led to cancellation of one in four trains (Turnbull, 2022) due to unavailability of workers as they protested a pay increase.

SR 3.1.2 Skill drought: The unavailability of trained, educated, or experienced segments of the workforce that are suitable and competent to carry out the tasks and activities of the infrastructure company. The risks of a skill drought are operational delays and disruption and revenue loss for infrastructure assets. For instance, airports are facing a shortage of baggage handlers post pandemic in the US, UK and the EU (Georgiadis, 2022) which is leading to long waits for baggage at carousels, ultimately threatening the social acceptability of the airport.

The following are the impact classes of the super-class of regulators:

S4 Regulators

Bodies that are tasked with regulation of infrastructure include the government, independent regulators such as OFWAT or prudential regulators. Regulatory processes generally comprise three stages: the enactment of enabling legislation, the creation of regulatory administrations and rules, and bringing those rules to bear on organisations whose behaviour is to be influenced or controlled.

SI 4.1 Regulator engagement Companies engage with regulators in various ways to try to use the regulatory process in favour of their business agenda. In addition to this, regulatory engagement allows for the company to proactively address risks that can harm the reputation of the company/sector with the regulators.

SI 4.1.1 Political contributions: Political or campaign contributions are used by companies to elect representatives who can influence policy to reduce competition, increase barriers to entry, and increase sales or profits for the company (UNESCO, 2012). For example, renewable energy companies donate money in election cycles to leaders that share their vision for clean energy. Contributions can also be used to support or finance activities of regulatory bodies whose views are aligned with those of the needs of the company. Regulatory oversight (e.g., laxity of regulations or severity of enforcement) may be influenced by such contributions, leading to unfavourable outcomes in the future. Public perception of the regulator's unbiasedness might also be impacted.

SI 4.1.2 Lobbying: Businesses lobby regulators in multiple ways (UNESCO, 2012):

- Direct lobbying: infrastructure companies use governmental relations specialists, industry trade associations, consultants, or a combination of these to directly lobby regulators into making policies favourable for their businesses.
- Indirect lobbying: infrastructure companies engage in indirect or grassroots lobbying by influencing employees, stakeholders, or the public to lobby policymakers on their behalf.

Lobbying can help introduce legislation that favours a specific industry, such as increasing protectionism or reducing competition. It can also help delay or forfeit regulatory oversight of the industry, which can lead to unfavourable outcomes for the public and risk the credibility of the regulator. Moreover, lobbying can shape laws that determine the scope of activities under the purview of a regulatory body. For example, successful lobbying by fossil fuel companies can delay the implementation of climate laws (such as the implementation of carbon tax), which can exacerbate climate change, causing physical risks to increase in intensity and frequency globally, resulting in a negative perception of the regulator.

SI 4.1.3 Litigation: Companies can impact the regulator by bringing litigation against the regulator. For example, see Global Affairs Canada (2019); Guernigou and Vidalon (2015); Global Affairs Canada (2017)

The following are the risk classes of the super-class of regulators:

SR 4.1 Regulatory risk: Changes in regulations or legislation can affect a company or industry as companies are required to abide by governing regulations. Regulations can increase costs of operations, introduce legal and administrative hurdles, and sometimes even restrict a company from doing business (CFI, 2020).

SR 4.1.1 Climate related (Transition risk): (Financial) Risks to companies and sectors resulting from the global shift to a low carbon future. The TCFD (2020) framework identifies four types of Transition risks, namely: policy and legal changes, reputation impacts, and shifts in market preferences and technology. This

includes the creation of taxes based on the carbon emissions and carbon intensity of the activity, as well as caps on service provision or production (mandatory shutdowns, ban on capacity addition). This could include scope 1 and 2 but also the scope 3 of assets depending on the nature of the activity and the objective of the regulator to manage demand. As a result, infrastructure assets could become stranded or there could be an uncertain subsidy landscape, changing with technological advancements. This increases uncertainy and can put the financial viability of certain projects at risk (e.g., renewable energy projects).

SR 4.1.2 Not climate related: Poor performance on the part of infrastructure companies can pose the risk of intervention from government and regulators which can manifest in the form of fines, nationalisation (where applicable) and business closure.

GOVERNANCE PILLAR

The governance of a company refers to corporate governance.

Corporate governance refers to systems of rules, practices, processes and strategies by which a firm is managed and controlled. It involves defining relationships between a company's management, its board, its shareholders and other stakeholders. Corporate governance also provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance are determined. The objects of corporate governance is to facilitate effective management and processes that leads to a long term success of the company.

The governance pillar of the taxonomy are presented in table 4. The definitions of each of these is presented in the following sections.

The G20 and OECD Principles of Corporate Governance (Organisation for Economic Co-operation and Development, 2015), outlines the following principles to ensure effective corporate governance of firms:

The following are the classes of the super-class of principles of corporate governance:

G1 Ensuring the basis for an effective corporate governance framework: The corporate governance framework should promote transparent and fair markets, and the efficient allocation of resources. It should be consistent with the rule of law and support effective supervision and enforcement (Organisation for Economic Co-operation and Development, 2015).

G2 The rights and equitable treatment of shareholders and key ownership functions: The corporate governance framework should protect and facilitate the exercise of shareholders' rights and ensure the equitable treatment of all shareholders, including minority and foreign shareholders. All shareholders should have the opportunity to obtain effective redress for violation of their rights (Organisation for Economic Co-operation and Development, 2015).

G3 Institutional investors, stock markets, and other intermediaries: The corporate governance framework should provide sound incentives throughout the investment chain and provide for stock markets to function in a way that contributes to good corporate governance (Organisation for Economic Co-operation and Development, 2015).

G4 The role of stakeholders in corporate governance: The corporate governance framework should recognise the rights of stakeholders established by law or through mutual agreements and encourage active co-operation between corporations and stakeholders in creating wealth, jobs, and the sustainability of financially sound enterprises (Organisation for Economic Co-operation and Development, 2015).

Table 4: Governance Pillar

G1	Ensuring the basis for an effective corporate governance framework
G2	The rights and equitable treatment of shareholders and key ownership functions
G3	Institutional investors, stock markets, and other intermediaries
G4	The role of stakeholders in corporate governance
G5	Disclosure and transparency
G6	The responsibilities of the board

G5 Disclosure and transparency: The corporate governance framework should ensure that timely and accurate disclosure is made on all material matters regarding the corporation, including the financial situation, performance, ownership, and governance of the company (Organisation for Economic Co-operation and Development, 2015).

G6 The responsibilities of the board: The corporate governance framework should ensure the strategic guidance of the company, the effective monitoring of management by the board, and the board's accountability to the company and the shareholders (Organisation for Economic Co-operation and Development, 2015).

5. The Way Ahead

This ESG taxonomy of impacts and risks is a standard agnostic, parsimonious matrix of ESG risks and impacts classes and sub-classes relevant for infrastructure assets. It is, at the most general level, universally applicable to any infrastructure company. By providing a list of ESG impacts and risk classes, it provides a framework to which other ESG standards and scheme can be compared. Further, by identifying all possible impacts and risks relevant for infrastructure companies, our taxonomy facilitates the understanding and quantifying of ESG risks and impacts.

A recent survey by EDHEC*infra* (Blanc-Brude et al., 2022) found that the most relevant impact classes for infrastructure investors are those of climate impact, and the most relevant risk classes are those of physical, transition and social acceptability risks. As a starting points, these are the impacts and risks that form a focus of the data collection exercise at EDHEC*infra*. Data measurement will be done in an objective, systematic manner calculated using a set of globally observable factors. For example, the Scope 3 emissions of airports can be measured by estimating the LTO and cruise emissions of airplanes.

In order to guide the data collection and subsequent measurement of the sub-set of identified ESG impacts and risks, we are currently developing a set of documents called exposure profiles for all types of infrastructure assets globally. Materiality profiles are academic style documents that are backed up by sector-specific literature review. The profiles review methodologies/initiatives used by sector-specific international organisations to measure/report ESG aspects of GHG estimations, physical risks, transition risk and social acceptability risks. They further present a list of science-based factors that can be used to determine the relative risk exposure or impact of any given infrastructure company. Thus, the exposure profiles are sector-specific extensions of the ESG taxonomy that enable the identification of factors to measure ESG impacts and risks

In other words, the materiality profile of a given infrastructure company or type of company is a collection of risk and impact attributes which can be used in combination to create a measure of materiality for each instance of risk or impact. The definition of the relevant attribute set should then be based on a clear theoretical and technical understanding of the key activities of the company, including what type of physical assets it includes and how they operate. The data generated with these profiles will enable the creation of a unique database of ESG impact and risk metrics for infrastructure investors.

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