

Adaptation Solutions Taxonomy

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An initiative led by:



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- + The authors of the Adaptation Solutions Taxonomy (or “ASAP Taxonomy”) are Chiara Trabacchi, Jay Koh, Serena Shi and Tara Guelig
- + The authors would like to acknowledge the following professionals for their cooperation and valued contributions to the ASAP Taxonomy

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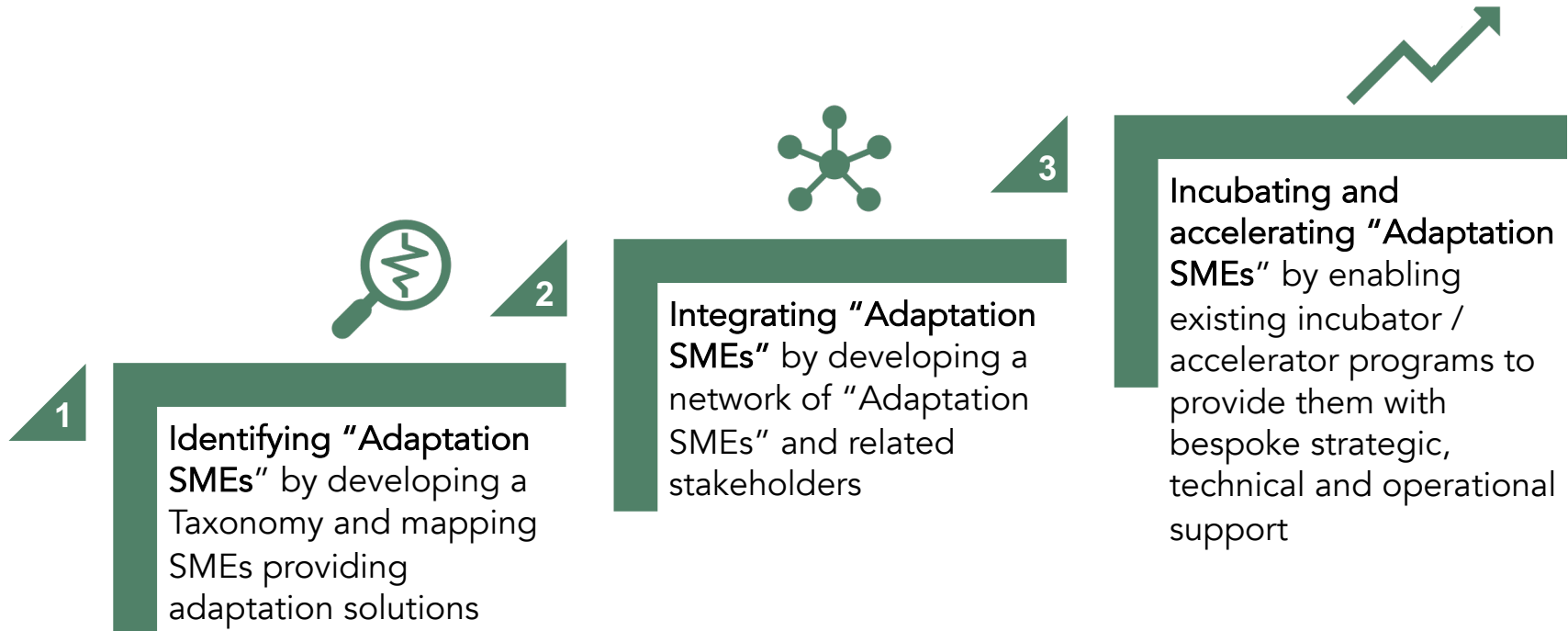
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1. Introduction

ASAP seeks to build the ecosystem of SMEs offering climate adaptation solutions in developing countries

ASAP

- + The Adaptation SME Accelerator Program (ASAP) aims to enhance the availability and uptake of climate adaptation solutions by identifying, engaging and empowering SMEs providing such solutions in developing countries
- + ASAP's three-pronged intervention strategy entails:



ASAP focuses on SMEs because of their potential role in supporting adaptation and their specific needs for growth

+ ASAP focuses on SMEs because they:

- + Have the potential to play an important role in providing solutions for climate adaptation
- + Play a major socio-economic role in developing countries, generating at least 45% of employment and as much as 33% of GDP in developing countries¹
- + Face specific challenges and barriers to growth and a specific lack of capacity to scale, which call for bespoke interventions²
- + Lack access to risk capital, which is a key constraint to their growth and to the transfer and supply of adaptation solutions

East Asia & the Pacific

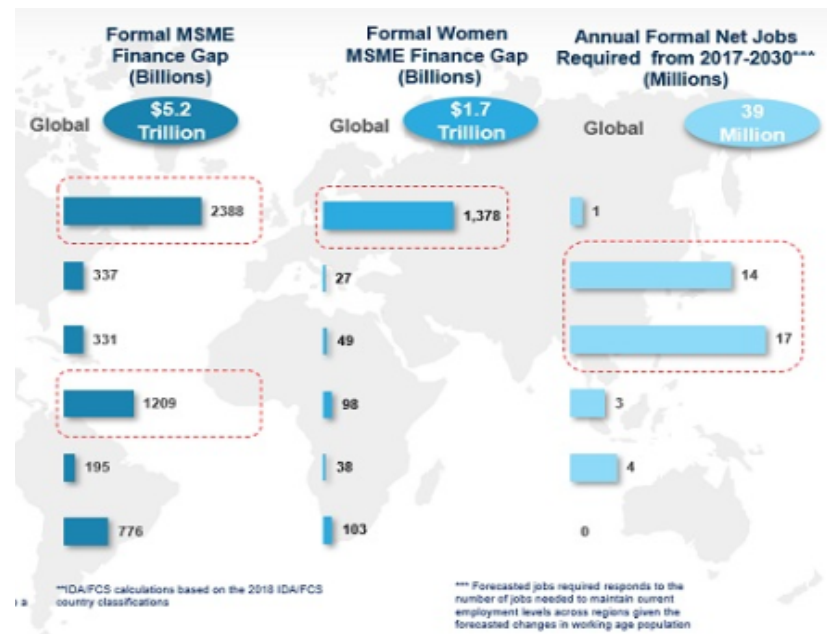
South Asia

Sub-Saharan Africa

Latin America & Caribbean

Middle East & North Africa

Europe & Central Asia



¹ International Finance Corporation (2010), *Scaling-Up SME Access to Financial Services in the Developing World*.

² Climate Policy Initiative (2018), *Understanding and Increasing Finance for Climate Adaptation in Developing Countries*.

Image Source: <https://www.worldbank.org/en/topic/smefinance>

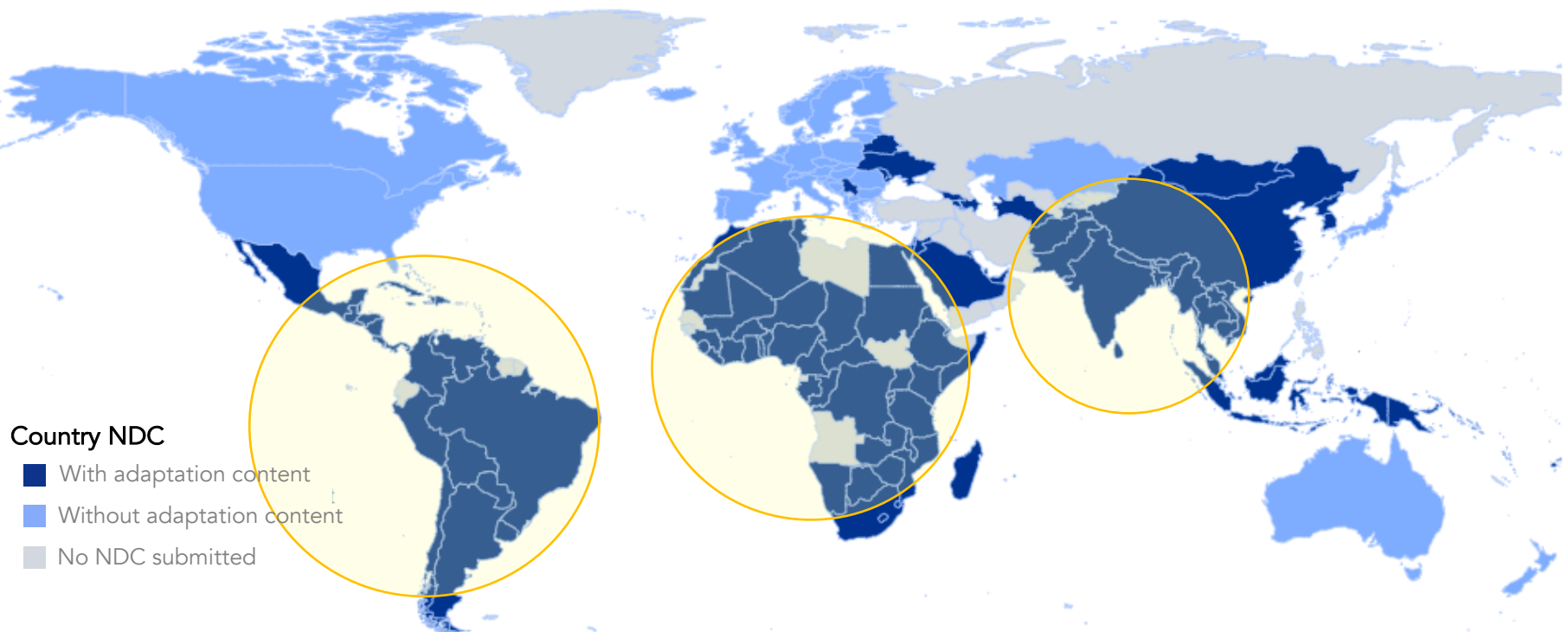
	Climate Adaptation Intelligence	Climate Adaptation Products and Services
GOAL	<ul style="list-style-type: none">+ Enhance a user's knowledge and understanding about the context- and location-specific risks and impacts of climate change and/or climate variability, including related determinants (exposure and vulnerability), to support decision-making and enable preparedness and early climate change action¹	<ul style="list-style-type: none">+ Enhance a user's ability to adapt to and/or build resilience to climate variability and change
DESCRIPTION	<ul style="list-style-type: none">+ Any type of climate data product, information, software and other tools that enable the identification, evaluation and/or monitoring of physical climate risks and related impacts (opportunities)	<ul style="list-style-type: none">+ Any product, equipment, technology or service that help to manage – avoid, mitigate and/or transfer – physical climate risks and related impacts, and adapt to climate change
EXAMPLES	<ul style="list-style-type: none">+ Climate and weather modeling for preventive planning and climate advisory services for risk assessment	<ul style="list-style-type: none">+ Drip irrigation, an energy technology helping to enhance the reliability and security of electricity supply or parametric and weather-index-linked insurance

For **IDENTIFYING** and **ASSESSING** physical climate risks

For **ADDRESSING** physical climate risks

¹ Adapted from the definition of Climate Services provided by IPCC (2018).

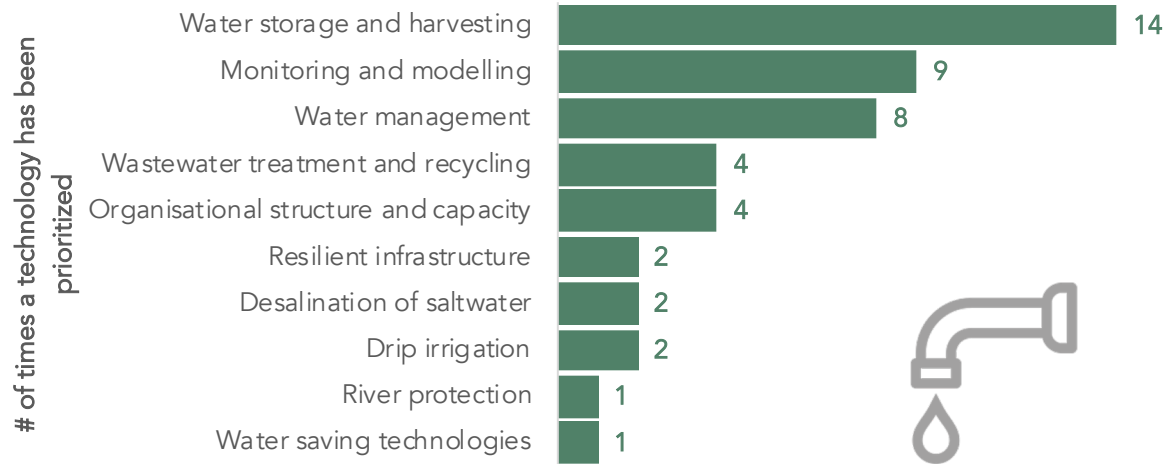
- + ASAP targets SMEs offering climate adaptation solutions in developing countries across Latin America and the Caribbean, Africa, and Asia
- + Adaptation is a key development priority for many developing countries in these regions, evidenced by significant portion of NDCs submitted that include a section on climate adaptation — 75% of the total. Agriculture, water and health are highlighted as key priority sectors.



ASAP seeks to enhance the supply and uptake of climate adaptation solutions most needed in developing countries

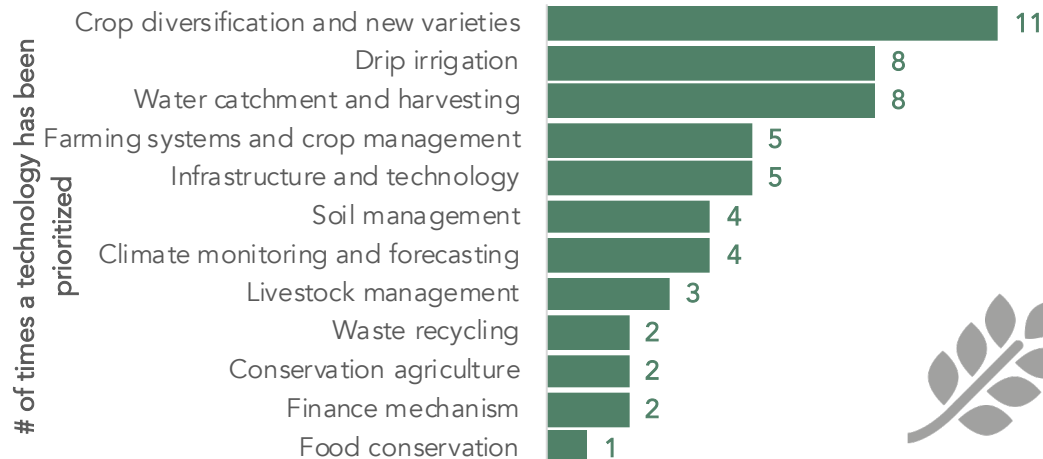


Water Sector Solutions Priorities



+ Water storage and harvesting, and water monitoring and modelling are top priority climate adaptation solutions sought by developing countries to address climate-related risks in the water sector

Agriculture Sector Solutions Priorities



+ Drip irrigation systems are at the top of the list of solutions for climate adaptation in the agricultural sector

ASAP targets the key barriers to the supply and uptake of climate adaptation solutions

Key barriers targeted by ASAP



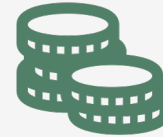
Institutional, regulatory & policy failures

- + Missing or deficient policy/regulatory frameworks including e.g., mispricing of natural resources and distortive subsidies, inadequate support to SME ecosystems, inadequate market signals



Knowledge & technical capacity barriers

- + Inadequate awareness/understanding of the risks/opportunities of climate change
- + Inadequate availability of decision-useful information, data and tools to integrate short, medium and longer-term climate change considerations into site-specific business decision-making
- + Inadequate capacity, knowledge and "know-how"






Market failures & financial barriers

- + Unknown or uncertain payback / benefits
- + Inadequate access to finance
- + Risk aversion



Technology barriers and challenges

- + Inadequate track record
- + Mismatch between the available climate solutions and the unexpressed needs of users
- + Gaps in technology maturity, transfer, diffusion, innovation including lack of appropriate technology to use climate services
- + Inadequate access to fit-for-purpose data / data standardization and scientific barriers e.g. computing capacities limits

	I. Identification	<ul style="list-style-type: none">+ Develop a taxonomy of adaptation companies and solutions+ Map regional market sizes, segments, and drivers+ Identify 300 adaptation SMEs and complete 6-12 investment case studies across regions
	II. Integration	<ul style="list-style-type: none">+ Call at least 3 regional adaptation SME convenings+ Establish community & on-line platform of adaptation SMEs+ Share best practices, engage cross region and with governments
	III. Incubation and Acceleration	<ul style="list-style-type: none">+ Develop climate adaptation-specific curriculum and “toolkits” for existing regional incubator/accelerator programs+ Integrate adaptation SMEs into at least 5 of these incubator/accelerator programs to enhance their capabilities+ Support engagement of SMEs with accelerators

2. Adaptation Solutions Taxonomy's Objectives and Methodology

+ The ASAP Adaptation Solutions Taxonomy is a tool developed with the aim of

- 1 Establishing a structured approach for transparently determining whether an SME qualifies as “Adaptation SME” based on the type(s) of technologies, products and services offered
- 2 Identifying areas in which SMEs may require targeted support during the engagement, incubation/acceleration phases of ASAP to avoid maladaptation and adopt best environmental and social risk management practices
- 3 Creating a flexible and inclusive framework that can be applied beyond the ASAP initiative to any company, regardless of size/scale or geography

The ASAP Taxonomy is designed to be a dynamic, flexible and inclusive tool



- + Four main elements compose the proposed Adaptation Solutions Taxonomy, namely: (i) a definition of “Adaptation SME”, (ii) eligibility criteria, (iii) a classification of “Adaptation SMEs”, and (iv) a results framework to measure, monitor and report on climate adaptation-related outcomes
- + The proposed Taxonomy is intended to be:
 - + **A dynamic and flexible tool**, evolving over time along with experience, expertise, market dynamics and changing adaptation needs
 - + **Inclusive**, to encompass SMEs that do not self-identify their technologies, products and services as adaptation solutions. This is because SMEs often do not label their solutions as “adaptation” / “climate resilience”-related and because what constitutes adaptation today in a given context can evolve
 - + **Applicable to any sector** in recognition that Adaptation SMEs’ solutions can be suited to multiple sectors and that climate change will affect all sectors of an economy, and all sectors must adapt to climate impacts
- + Given the location- and context-specific nature of climate adaptation, the Taxonomy does not provide a stand-alone list of technologies, products and services that could be viewed as contributing to adaptation in all circumstances. Rather, it seeks to offer a framework to identify eligible companies based on the type(s) of technologies, products and services they provide. The framework, however, does recognize and build on existing adaptation-relevant taxonomies, some of which provide clear examples of adaptation solutions

The Taxonomy builds on existing standards and frameworks to support international harmonization and broad adoption

- + The proposed Taxonomy builds on existing definitions, taxonomies and approaches¹ in pursuit of international harmonization, in particular:
 - + EU Taxonomy for sustainable activities
 - + Climate Bonds Initiatives (CBI)'s Climate Resilience Principles
 - + European Market for Climate Services (EU-MACS) project
 - + Intergovernmental Panel on Climate Change (IPCC)
 - + Joint MDB methodology for tracking climate change adaptation finance
 - + Joint MDB IDFC Framework for Climate Resilience Metrics
 - + Market Research for a Climate Services Observatory (MARCO) project
 - + Task Force on Climate-related Financial Disclosures (TCFD)
 - + UNFCCC Climate Technology Centre and Network (CTCN) Taxonomy
- + Beyond ASAP, the Taxonomy has been developed for use by a broader range of users, which includes:



SMEs themselves



Market participants (e.g., investors, lenders, end-users of SME's solutions, incubators and accelerators)



Governments and other public-goods oriented organizations

¹ See Annex for more detail.

The development of the Taxonomy required a multi-step approach

- 1 Desk-based review of existing definitions, taxonomies, frameworks and approaches
- 2 Desk-based review of sectors demanding/in need of adaptation solutions, and of existing segmentations of climate adaptation solutions
- 3 Desk-based review of existing frameworks, principles and methodologies for measuring adaptation-related outcomes
- 4 Development of proposed Taxonomy for “Adaptation SMEs”
- 5 Peer review and fine-tuning

Key definitions underlying the Taxonomy (1/4)

Term	Definition	Source
Adaptation	<p>An economic activity shall be considered to contribute substantially to climate change adaptation where that:</p> <ul style="list-style-type: none"> a) Economic activity includes adaptation solutions that either substantially reduce the risk of adverse impact or substantially reduces the adverse impact of the current and expected future climate on that economic activity itself without increasing the risk of an adverse impact on other people, nature and assets; or where b) Economic activity provides adaptation solutions that [...] contribute substantially to preventing or reducing the risk of adverse impact or substantially reduces the adverse impact of the current and expected future climate on other people, nature or assets, without increasing the risk of an adverse impact on other people, nature and assets. 	EU Technical Expert Group on Sustainable Finance (2020), Taxonomy Report: Technical Annex (2020) ¹
Adaptation solutions²	<p>Technologies, products, or services that can help the identification, assessment, management/transfer and/or monitoring of physical climate risks and their impacts</p> <ul style="list-style-type: none"> + Climate information, data products, software and other tools that enhance users' knowledge and understanding about the risks/impacts of climate change and/or climate variability to support decision-making and enable preparedness and early climate change action.³ + Products and services: i.e., any equipment, technology or service needed to prevent, mitigate or transfer physical climate risks and adapt to climate change 	Adapted from CTCN ; GARI (2016) IPCC (2018) UNFCCC (2014) ;
Climate Resilience	Climate resilience is the strengthening of a system to withstand climate-related shocks or stressors. [...] Climate resilience is the capacity of a system to cope with, or recover from, those effects, while retaining the essential components of the original system.	Joint-MDB/IDFC (2019)
Resilience	The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure while also maintaining the capacity for adaptation, learning and transformation	IPCC (2018)

¹ The definition outlined in the EU Taxonomy is broadly consistent with that provided by the IPCC i.e., "In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects ([IPCC \(2018 - Annex I: Glossary\)](#)).


² In the EU Taxonomy, adaptation solutions refers to "the set of all possible measures, actions, adjustments, changes, applications, products, services, etc. that contribute to adapt to a changing climate".

³ Adapted from the definition of Climate Services provided by [IPCC \(2018\)](#).

Term	Definition	Source
Exposure	The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.	IPCC (2018)
Hazard	The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources.	IPCC (2018)
Impact	The consequences of realized risks on natural and human systems, where risks result from the interactions of climate-related hazards, exposure, and vulnerability.	IPCC (2018)
Physical Risks	Physical risks from climate change encompass both: + <u>Acute risks</u> : i.e., those that are event-driven, arising from extreme weather events such as cyclones, hurricanes, or floods + <u>Chronic Risks</u> : i.e., those arising from longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise	TCFD (2017)
Risk	The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. Risk results from the interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.	IPCC (2018)
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.	IPCC (2018)

Key definitions underlying the Taxonomy (3/4)

Results chain

A vertical green arrow on the left side of the table, pointing downwards, with the text "Results chain" written vertically alongside it.

Term	Definition
Activities	Actions taken, work performed, and inputs mobilized by ASAP to deliver on its goals
Inputs	Financial, human, and material resources invested by ASAP to deliver on its goals. These may vary in breadth and depth depending on e.g., Adaptation SMEs' specific needs
Outputs	The market-related changes resulting from ASAP's effects on the supply/demand of climate adaptation solutions in developing countries
Outcomes	The likely or achieved short-and medium-term effects resulting from the use of climate adaptation solutions, which may take the form of adjustments of physical, human, or environmental systems and associated socio-economic development benefits, resulting from the response to the context of climate vulnerability
Impacts	The primary and secondary long-term effects of ASAP, directly or indirectly, intended or unintended, that may contribute to longer-term climate resilience, adaptive capacity, and/or reduced climate vulnerability

Term	Definition	Source
Developing countries	IDA and IBRD's borrowing countries	World Bank Country and Lending Groups
SMEs	<p>An enterprise qualifies as a small or medium enterprise if it meets two out of three following criteria – verified to the extent possible and on a best-efforts basis, based on the best publicly available information:</p> <ul style="list-style-type: none"> + <u>Small</u>: <ul style="list-style-type: none"> + <i>Employees</i>: 10 - 49 + <i>Total assets</i>: US\$100,000 - US\$3 million + <i>Annual sales</i>: US\$100,000 - US\$3 million + <u>Medium</u>: <ul style="list-style-type: none"> + <i>Employees</i>: 50 – 300 + <i>Total assets</i>: US\$3 million – US\$15 million + <i>Annual sales</i>: US\$3 million – US\$15 million 	IFC's definitions

3. Definition of "Adaptation SME" and eligibility criteria

- + An “Adaptation SME” is a company providing technologies, products and/or services that:

Address systemic¹ barriers to adaptation by strengthening users’ ability to understand and respond to physical climate risks and related impacts and/or capture related opportunities

AND
/ OR

Contribute to preventing or reducing material physical climate risk² and/or the adverse associated impacts on assets, economic activities, people or nature

Examples:

- + Weather and climate analytics
- + Hydrological forecasting modelling
- + Remote sensing-based tools for physical climate risk exposure assessment

Examples:

- + Water-efficient irrigation systems
- + Water storage and harvesting
- + High precision laser land leveling to reduce runoff
- + Geosynthetic products

¹ According to the EU Taxonomy, “systemic adaptation” activities aim to “actively reduce vulnerability and build resilience of a wider system, or systems, such as a community, ecosystem, or city”. According to the Joint-MDBs/IDFC (2019), “system” refers to the “wider context e.g., livelihood, transport and logistics, supply chain, value chain, information and communication, market, ecology”.

² As per the EU Taxonomy, “material physical climate risk” refers to the risk of financial and/or non-financial losses occurring due to performance failures, performance delays or incomplete performance of an economic activity/assets resulting from climate-related hazards. Materiality is location- and context-specific.

Eligibility screening criteria to identify eligible "Adaptation SMEs"

+ To qualify as Adaptation SME, an SME's technology, product, or service offering must:

Enable a user to identify, evaluate, manage and/or monitor physical climate risks and impacts (opportunities), thereby contributing to prevent or reduce context- and location-specific risk of adverse impacts, or the adverse impacts, of the current and expected future climate on assets, economic activities, people or nature

The context- and location-specific relevance assessment must be grounded in robust evidence, e.g., existing analyses such as IPCC reports, countries' NDCs, etc.

Enable a user to address systemic barriers to adaptation by e.g. addressing information, capacity, technological or financial barriers to adaptation by others

AND
/ OR

Be offered in developing countries

AND

The contribution to adaptation — adaptation-related outcomes — can be defined and qualitatively and/or quantitatively measured and monitored

AND

An SME qualifies as an Adaptation SME if:

Offering solutions
in developing
countries

ASAP Activities

Screening
stage
(mapping)

Enables a user to address
systemic barriers to climate
adaptation

Contributes to preventing or
reducing context- and
location-specific risk of adverse
impacts, or the adverse
impacts of the current and
expected future climate

ASAP maps SMEs offering solutions relevant with sectoral, regional, and/or nation-wide climate adaptation needs and efforts

Engagement
stage

- + Operates in compliance with relevant E&S standards and local regulation
- + Commits to put in place actions to:
 - Increase its own resilience to climate change risks and impacts
 - Adopt best available knowledge to provide solutions that do not lead to maladaptation (of the direct user or the system in which the user operates)
 - Build the awareness and capacity of the target users of their solutions to avoid maladaptation
 - Apply best environmental & social safeguards practices

ASAP (incl. via convenings and incubators/accelerators) will support SMEs in meeting the criteria of the Taxonomy. This would encompass e.g., capacity building to support them in building the awareness and capacity of the users of their solutions and meet ESG management and impact measurement standards (via ESG and impact measurement toolkit).

Its contribution can be quantitatively and/or qualitatively measured

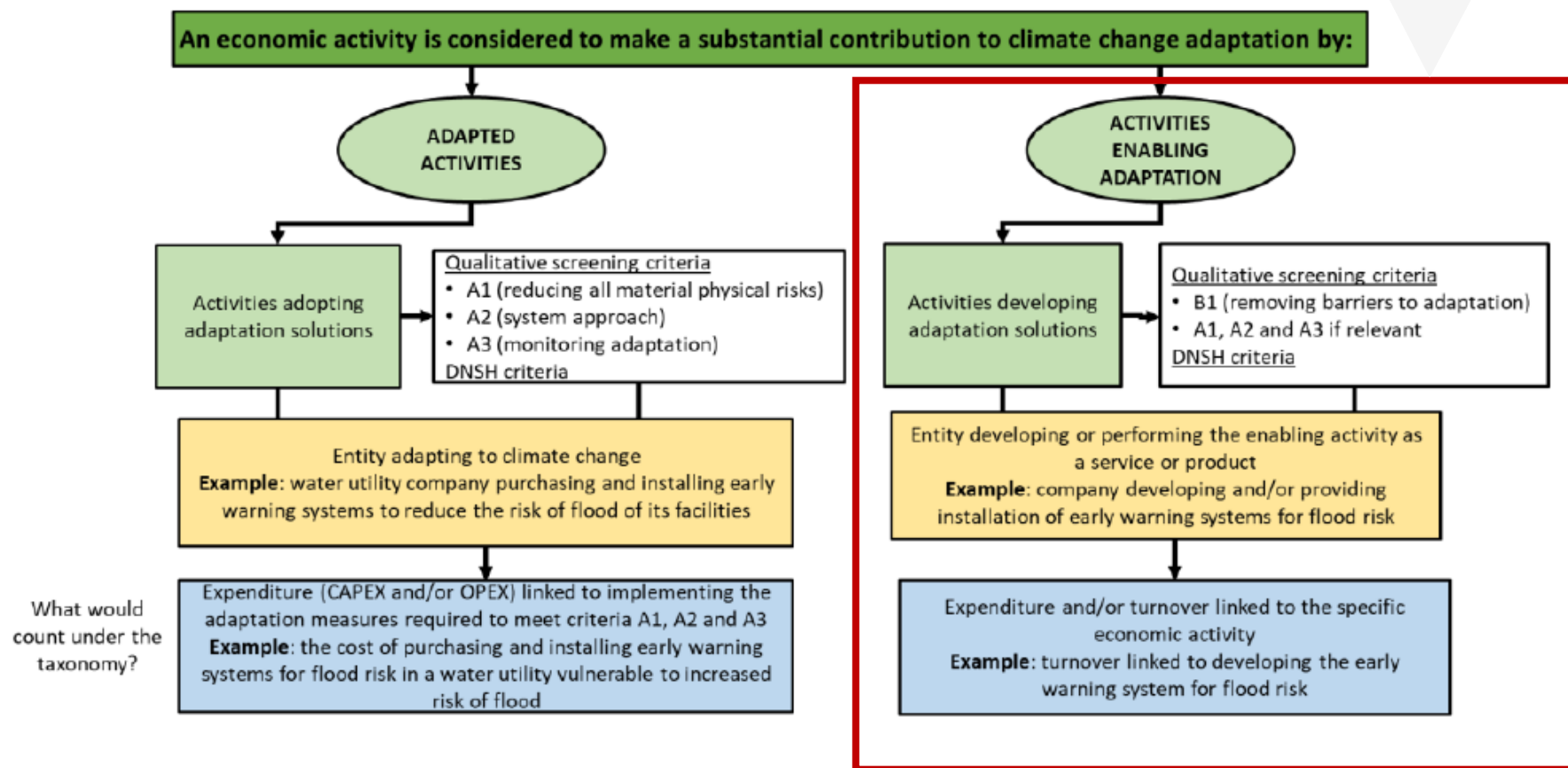
→ To “Do No Significant Harm” and generate long-term value

- + **The proposed definition and related screening criteria build on the ones of the EU Taxonomy for sustainable activities** and have been informed by the definitions, frameworks and approaches adopted by Bi-Multilateral Development Banks, Climate Bonds Initiative's Climate Resilience Principles, and the Global Adaptation and Resilience Investment (GARI) Working Group (see Annex A)
 - + Under the EU Taxonomy, "Adaptation SMEs" fit under the "activities enabling adaptation of an economic activity" typology of activities substantially contributing to adaptation objectives
 - + As per the EU Taxonomy, the eligibility screening criteria are qualitative in nature. An established methodology for defining quantitative screening criteria does not exist given the lack of measured baselines or accepted metrics for climate adaptation. Further, as noted in the EU Taxonomy, "quantitative screening criteria could exclude small-scale activities that may deliver significant climate-resilience benefits in specific contexts"
- + **The ASAP Adaptation Solutions Taxonomy refrains from establishing quantitative eligibility criteria** thresholds based on targeted SME's adaptation-related revenue or spending. This is because: (i) the objective of ASAP is to foster and scale-up the provision and availability of adaptation solutions from the private sector, and (ii) data limitations, especially at the screening stage
 - + ASAP seeks to enhance understanding and awareness of the ecosystem of SMEs providing climate adaptation solutions in developing countries
 - + ASAP focuses on enhancing targeted SMEs' climate adaptation-related existing business lines and new adaptation-related opportunities
 - + Note: The EU Taxonomy similarly does not establish revenue or spending thresholds. Rather, it calls for the disclosure of Taxonomy-eligible "revenue and/or expenditure associated with the economic activity that meets the relevant screening criteria" e.g., revenue linked to developing early warning systems for flood risk

The ASAP Adaptation Solutions Taxonomy builds on the EU Taxonomy

EU Taxonomy: decision tree for determining substantial contribution to climate change adaptation

ASAP specifically focuses on Activities Enabling Adaptation



Taxonomy is designed to be inclusive given Adaptation SMEs' solutions are wide-ranging – across physical risks and impacts and across multiple sectors

Climate-related impact drivers¹



Extreme temperature



Extreme precipitation



Damaging cyclone



Sea level

Sector	Examples of projected climate change impacts	Examples of adaptation solutions	
		Climate Adaptation Intelligence	Climate Adaptation Products and Services
Agriculture	<ul style="list-style-type: none"> + Reduced crop yields and quality resulting from higher temperatures and/or less precipitation + Reduced crop yields in irrigated agriculture due to reduced availability of irrigation water + Crops losses due to extreme weather events 	<ul style="list-style-type: none"> + Climate monitoring and forecasting + Temperature regulation technologies for livestock + Remote sensing-based drought monitoring tool + Crop data and analytics platform with mapping interface 	<ul style="list-style-type: none"> + Drought tolerant crops + High precision laser land leveling to reduce runoff + Pressurized irrigation technologies using sprinkler, drip, mini-sprinkler, or high-efficiency drip systems + Parametric insurance
Coastal zones	<ul style="list-style-type: none"> + Damage to assets from more intense and frequent extreme weather events + Flooding due to sea level rise and storm surges + Reduced of domestic, commercial, or industrial water due to saltwater intrusion + Erosion due to rising sea level 	<ul style="list-style-type: none"> + Early warning systems for extreme coastal weather events + Satellite imagery for monitoring and impact assessment + Sea-level processing software 	<ul style="list-style-type: none"> + Geosynthetics (e.g., geotextiles and geomembranes) + Constructed wetlands and artificial reefs
Health	<ul style="list-style-type: none"> + Changes in the geographic range, seasonality, and incidence of vector- and water-borne diseases + Reduced labor productivity due to heat stress + Increased respiratory illness due to heat stress 	<ul style="list-style-type: none"> + Disease surveillance systems + E-Health e.g. remote diagnostics, health and disease surveillance systems for outbreak detection 	<ul style="list-style-type: none"> + Long-lasting insecticidal nets + Rapid diagnostic tests
Transport	<ul style="list-style-type: none"> + Damage to road network / rail network / seaports due to extreme weather events + Interruption of transport networks due to extreme weather events + Flooding and inundation of transportation infrastructure due to rising sea levels 	<ul style="list-style-type: none"> + Intelligent transportation systems to e.g. monitor road conditions, address hazards in real time, moving traffic away from areas experiencing a natural disaster, point first responders to identify priority intervention areas 	<ul style="list-style-type: none"> + Extreme heat/cold resistant paving material + Active motion-dampening systems
Water supply and mngt.	<ul style="list-style-type: none"> + Reduced surface-water availability due to changes in precipitations + Reduced surface water quality due to e.g., saltwater intrusion + Increased flooding due to extreme weather events 	<ul style="list-style-type: none"> + Water monitoring and modelling (e.g. water resource mapping) + Hydrological forecasting system 	<ul style="list-style-type: none"> + Water storage and harvesting + Water saving technologies / water loss reduction technologies e.g., smart water meters, pressure control equipment

¹ Note: List of hazards is non-exhaustive. © IPCC, 2014: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., et al.]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1132 pp.

Sources: GARI (2016), *Bridging the Adaptation Gap*; ADB (2014), *Technologies to Support Climate Change Adaptation in Developing Asia*; Zhu, X et al. (2011), *Technologies for Climate Change Adaptation - Agriculture Sector*; Christiansen et al. (2011), *Technologies for Adaptation - Perspectives and Practical Experiences*.



AGRICULTURE | Wine industry

- + Key climate risks: damages to yields and yield composition.
- + Climate adaptation intelligence use: (i) obtain guidance on how to adapt agronomic practices to increased frequency and severity of water deficits and heatwaves; (ii) understand potential pathogens' invasion and associated economic impacts.



WATER AND SANITATION

- + Key climate risks: Reduction of aquifers recharge; change in water quality and in contamination characteristics; changes in the physical characteristics of water.
- + Climate adaptation intelligence use: providing access to decision-useful information on climate events to support adaptation planning decision-making; providing data, models and scenarios for operational and strategic management of the water system.



REAL ESTATE

- + Key climate risks: Damage to physical structures; disruption of business operations; and health and safety issues for occupants and construction site workers, flooding and sewage overflow.
- + Climate adaptation intelligence use: urban zoning and planning; climate risk screening during feasibility stage, performance test of new climate adaptation solutions, decision support.



AGRICULTURE | rainfed crops

- + Key climate risks: lower crop yields and quality due to changing precipitation patterns resulting in floods or extended droughts.
- + Climate adaptation product: drip irrigation → enables the supply of water in frequent small amounts to the exact place where crop plants can utilize it most efficiently. It can help to increase crop yields while conserving agri-related inputs, water resources, as well as result in labor and energy savings.



WATER AND SANITATION

- + Key climate risks: reduced availability of water for domestic, commercial or industrial use due to changes in precipitation, increased evaporation, increased glacier melt.
- + Climate adaptation product: water metering → helps reduce water consumption, detect and pinpoint leakages in the system and provide information to utilities about consumer behavior that can be used in water conservation campaigns.

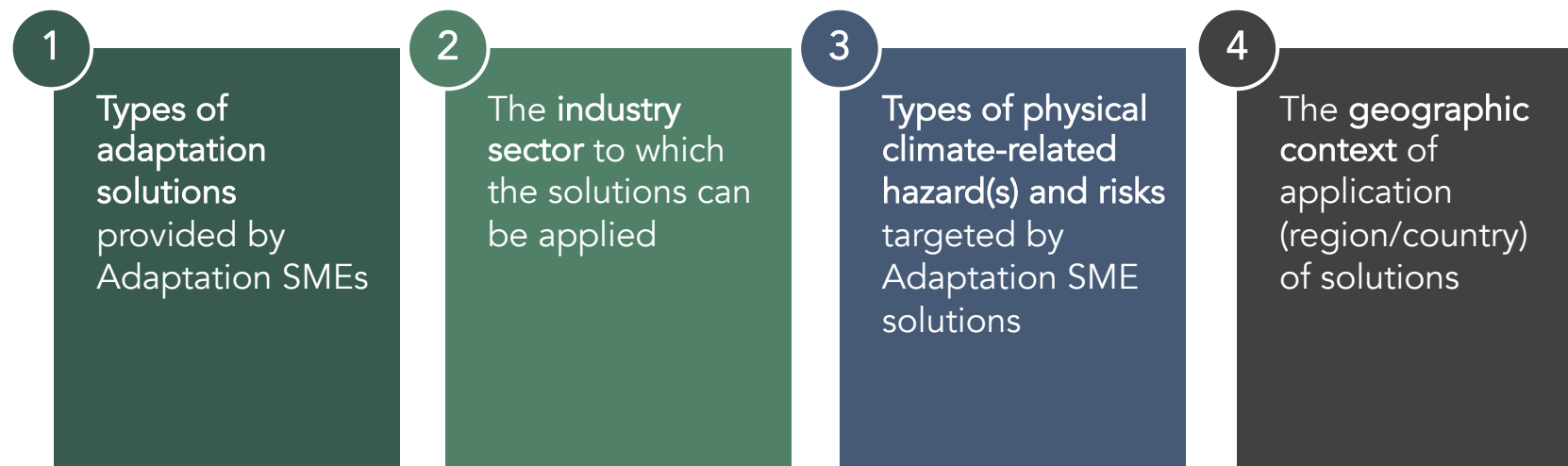


COASTAL ZONES

- + Key climate risks: damages to the built environment and/or disruptions to transportation networks due to coastal flooding and erosion caused by sea level rise or more intense and frequent extreme weather events.
- + Climate adaptation product: geosynthetic products (geotextiles, geogrids, geonets, geomembranes, geofoam, geocells, and geocomposites) → help to control floods, manage erosion, and provide protection against damage from waves or currents.

4. A classification of Adaptation SME solutions

- + The classification proposed herein aims to communicate the need and opportunity for **climate adaptation solutions** to both Adaptation SMEs and the users of their solutions. To this end, the classification considered the following dimensions:



- + It builds on the classifications adopted by existing taxonomies, frameworks, and methodologies (see *Annex B*), and may be refined as a result of further road-testing.

The proposed classification can inform the development of a user-centric online database of Adaptation SMEs

- + The proposed classification intends to inform the development of an online database aimed at facilitating users' identification and uptake of Adaptation SME solutions

User questions to address	Key dimensions for the online database
<i>Who provides adaptation solutions?</i>	Adaptation SME name
<i>What does it provide?</i>	Type of adaptation solution
<i>Do the solutions help to <u>assess</u> and/or <u>address</u> physical climate risks?</i>	Climate Adaptation Intelligence and/or Climate Adaptation Products & Services
<i>To which economic activities can the adaptation solutions be used/applied?</i>	Targeted industry sector
<i>What type of physical climate risks can the solutions help address?</i>	Targeted physical climate hazard/risk
<i>Where are the solutions available?</i>	Geographic scope

By Adaptation solution type ¹	
Climate Adaptation Intelligence	Advisory services for e.g. climate risk exposure and vulnerability identification & assessment
	Data management and operations (e.g. provision of calibrated/validated data sets; collection and provision of raw data for global weather, and climate change applications)
	Decision-support tools (e.g. early warning systems, software performing cost/benefit analysis of adaptation solutions)
	Physical climate risk identification and impact assessment (e.g. spatial hazard and vulnerability mapping analysis, disaster risk assessment tools, systematic monitoring & remote sensing climate impact analysis)
Climate Adaptation Products and Services	Physical climate risk management (incl. e.g., water efficient irrigation technology, rainwater harvesting; crop storage, geosynthetics; etc.)
	Physical climate risk transfer (e.g. parametric insurance)

- + ASAP proposes a preliminary categorization by type of Adaptation SME solution to inform the demand for such solutions
- + Trade-offs exist in the breadth and granularity of the categorization of adaptation solutions by typology. ASAP opts for macro-categories that are detailed and clear enough to communicate the type of activity performed/output offered by an Adaptation SME's solution to target end-users and/or other relevant market participants (e.g., investors)
- + The categorization proposed builds on the approaches adopted by the [Climate Knowledge Hub](#), the [UN Climate Technology Centre & Network](#) (2017); [EU-MACS](#) (2017) and [MARCO project](#) (2018).

¹ Source: Adapted from [Climate Knowledge Hub](#), [EU-MACS](#) (2017) and [MARCO project](#) (2018); [IPCC AR5](#) (2014); [Ernst C and Blaha K.](#) (2015)

Sector	
+ A	Agriculture; forestry and fishing
+ B	Mining and quarrying
+ C	Manufacturing
+ D	Electricity; gas, steam & air conditioning supply
+ E	Water supply; sewerage, waste management and remediation activities
+ F	Construction
+ G	Wholesale and retail trade; repair of motor vehicles and motorcycles
+ H	Transportation and storage
+ I	Accommodation and food service activities
+ J	Information and communication
+ K	Financial and insurance activities
+ L	Real estate activities
+ M	Professional, scientific and technical activities
+ N	Administrative and support service activities
+ O	Public administration and defense; compulsory social security
+ P	Education
+ Q	Human health and social work activities
+ R	Arts, entertainment and recreation
+ S	Other service activities
+ T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use
+ U	Activities of extraterritorial organizations and bodies

- + The ASAP Adaptation Solutions Taxonomy classifies Adaptation SME solutions according to the European statistical classification of economic activities known as Nomenclature of Economic Activities (NACE)¹ in order to:
 - + Align with the EU Taxonomy
 - + Enable broader adoption of the Taxonomy, beyond the ASAP initiative
- + The Panel of Expert Peer Reviewers suggested aligning the Taxonomy with NACE over other sectoral classification systems considered (e.g., those used by UNFCCC's Climate Technology Centre & Network, one proposed by the MARCO project to classify Climate Services based on the sectors in which they are used (see *Annex* for more detail on these systems))
- + The relevance of Adaptation SME solutions across sectors will be dependent on location- and context-specific circumstances. The EU Taxonomy, for instance, prioritizes the following sectors given their relative level of vulnerability to climate change & socio-economic relevance: Agriculture, forestry and fishing; Information & Communication; Financial & Insurance Activities; Water Supply, Sewerage, Waste Management & Remediation Activities²

¹ NACE Rev. 2 corresponds to ISIC Rev. 4 - International Standard Industrial Classification of All Economic Activities.

² For more details refer to the EU Taxonomy (2020) page 393.

Sources: <https://ec.europa.eu/Eurostat>.

Classification of Adaptation SME solutions By targeted climate hazard and related risks

	Key climate-related hazards ¹	Key risks on physical and biological systems ¹	Key risks on human and managed systems ²
Temperature-related	<ul style="list-style-type: none"> + Temperature variability* + Changing temperature (air, freshwater, marine water)* 	<ul style="list-style-type: none"> + Heat stress* + Heat wave** + Cold wave/frost** + Wildfires** 	
Wind-related	<ul style="list-style-type: none"> + Changing wind patterns* + Cyclone, hurricane, typhoon** + Storm** + Tornado** 		<ul style="list-style-type: none"> + Reduced agricultural productivity and food security + Damages to physical infrastructure, property, and critical services
Water-Related	<ul style="list-style-type: none"> + Changing precipitation patterns and types (rain, hail, snow/ice)* + Precipitation variability* + Heavy precipitation** 	<ul style="list-style-type: none"> + Ocean acidification* + Saline intrusion* + Sea level rise* + Water stress* + Drought** + Flood** + Glacial lake outburst** 	<ul style="list-style-type: none"> + Reduction in water availability, quality and security + Business disruptions + Spread of pests, and vector-borne and water-borne diseases
Solid-Mass Related		<ul style="list-style-type: none"> + Glacial retreat, changes in ice, snow cover, permafrost thawing* + Coastal erosion* + Soil degradation & erosion* + Solifluction* + Ecosystem & biodiversity loss* + Avalanche** + Landslide** 	<ul style="list-style-type: none"> + Impacts to human health, and loss of livelihoods

* Chronic ** Acute

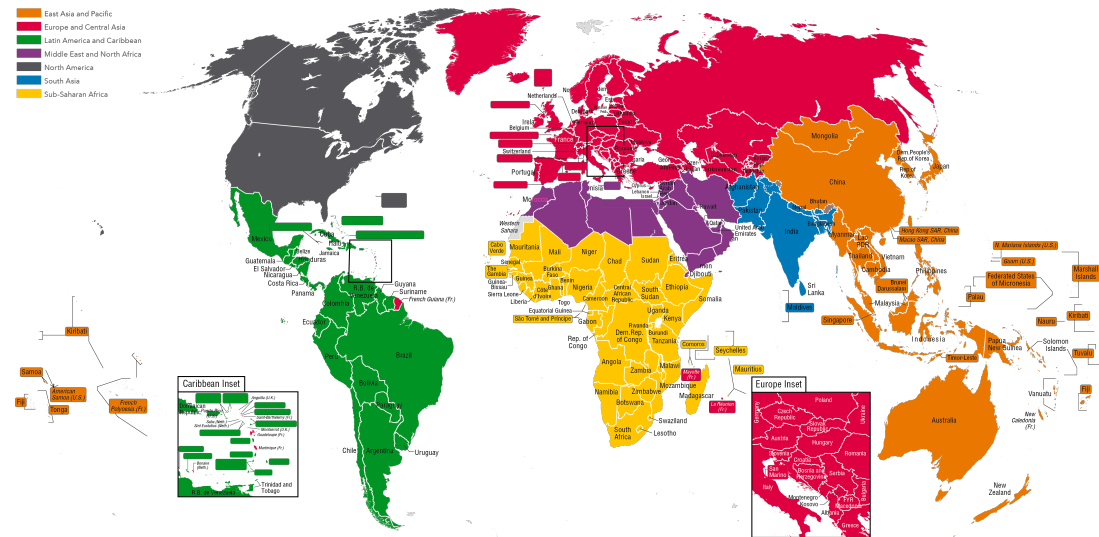
- + ASAP proposes a classification by climate-related hazards and related impacts to (a) inform the supply of / demand for climate adaptation solutions; and (b) support climate-related financial disclosures aligned with TCFD which recommends disclosure of the types of climate risks to which an organization may be exposed and, where material, the actual and potential impacts of climate-related risks and opportunities
- + Classification seeks to align with the EU Taxonomy classification of climate-related hazards while adopting the IPCC's distinction between climate-related hazards and risks on physical, biological and human systems. It also seeks to highlight those physical risk drivers potentially leading to economic costs and financial losses.
- + While aligning with the EU Taxonomy classification by major hazard group, authors recognize that risks to physical, biological and human systems can be driven by a combination of elements. For instance, the increased likelihood and severity of wildfire risks is determined by combination of high temperatures, low humidity, low rainfall and often high winds (see [here](#)).

¹ Non-exhaustive. Key differences from EU Taxonomy classification system: Removed "subsidence" and hydrological variability. Added ecosystem & biodiversity loss, glacial retreat, changes in ice and snow cover. ² Indicative, non-exhaustive set of climate-related risks and impacts identified in IPCC (2014), *Climate Change 2014: Synthesis Report*. See Annex for Figure 2.4 of the 2014 IPCC report for key climate-related risks by region. Sources: Adapted from IPCC (2013), *Climate Change 2013, The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the IPCC*; IPCC (2014), *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the IPCC*; EU TEG on Sustainable Finance (2020); NGFS (2019), *A Call for Action. Climate Change as a Source of Financial Risk*.

Classification of Adaptation SME solutions By targeted geography

Region	Country examples
East Asia & Pacific	+ Cambodia + Indonesia + ...
Europe & Central Asia	+ Tajikistan + Ukraine + Turkey + ...
Latin America & Caribbean	+ Argentina + Brazil + Colombia + ...
Middle East & North Africa	+ Morocco + Tunisia + Israel + ...
South Asia	+ India + Bangladesh + Sri Lanka + ...
North America ¹	+ United States + Canada
Sub-Saharan Africa	+ Ghana + Kenya + Nigeria + ...

- + Mapping climate adaptation solutions to geographical regions where the SME's intelligence, products and/or services are delivered and used helps to contextualize the solutions within geographies shaped by different climate impacts and vulnerabilities
- + The ASAP Adaptation Solutions Taxonomy adopts the classification of the World Bank list of economies



¹ ASAP is focused on SMEs delivering solutions in developing countries, but there may be instances where SMEs also serve customers in North America among other countries.

Case study: Example of a Taxonomy-aligned SME and related classification

AgTech Company Description

Company offers a cloud-based, software analytics platform that combines data from in-field sensors and satellite imagery with data received directly from farmers via micro-surveys to provide more accurate weather data and monitoring of growing conditions which can support better, more adaptive decision-making on the field and more accurate yield projections. The company's offering accomplishes the following:

- + Overcomes the shortcomings of satellite imagery, providing a more granular view of micro-climate effects that have different impacts on agricultural production and outputs
- + Can be used for a wide range of applications in agriculture, including agricultural insurance and lending, precision agriculture, as a value-add service for selling agricultural inputs, farm management, and disaster response

Application of Adaptation Solutions Taxonomy and Classifications

Adaptation SME Eligibility Screening

Criteria	Rationale
✓ Enables a user to address systemic barriers to climate adaptation relevant for the context	Field data and more precise weather analytics provide information (e.g., soil moisture, live weather conditions) that can help farmers make better decisions in the face of increased weather volatility, drought risk, etc.
✓ Solution is offered in developing countries	SME is based in South Asia and serves customers in South Asia
✓ Adaptation-related outcomes can be defined and measured	Sample impact KPIs might include: hectares of farmland covered, # of farmers served; liters of water saved; \$ of agricultural loans originated

Classification of Adaptation SME Solution

Type of adaptation solution	Climate Adaptation Intelligence → Decision-support tool
Targeted industry sector	A. Agriculture, Forestry and Fishing 0.1 Crop and animal production
Targeted physical climate hazard	+ Temperature-related + Water-related
Geographic scope	SME based in South Asia offering its solutions in South Asia

5. Measuring Adaptation SMEs' contribution to climate adaptation

There is no one-size-fits-all set of metrics for measuring the contribution of a given solution to climate adaptation

OBJECTIVE

- + This section introduces preliminary considerations and an initial framework for evaluating the contribution of Adaptation SMEs to adaptation outcomes → The results framework and related indicators will be developed further in subsequent phases of ASAP

BACKGROUND

- + Valorizing physical climate risks and related impacts and the benefits associated with investments in adaptation solutions is critical to driving private investment in climate resilience solutions
- + **At present, there is no one-size-fits-all set of metrics for measuring adaptation benefits.** Accepted metrics have not yet been developed¹ due to the complexity associated with evaluating physical climate risks and the outcomes of physical climate risk management interventions. Key issues include:
 - + It is difficult to establish baselines and determine the causality between an intervention and adaptation outcome(s) given the inherent uncertainties associated with climate change impacts and the long-time horizon that might span between a given intervention and its results.
 - + What constitutes success following an adaptation intervention changes over space and time, as climate change impacts differ across sites, temporal and spatial scales, and affects a series of sectors.²
 - + The great heterogeneity and diversity of potential physical climate-related risks and responses makes it challenging to define universal metrics. A context-specific approach is required.

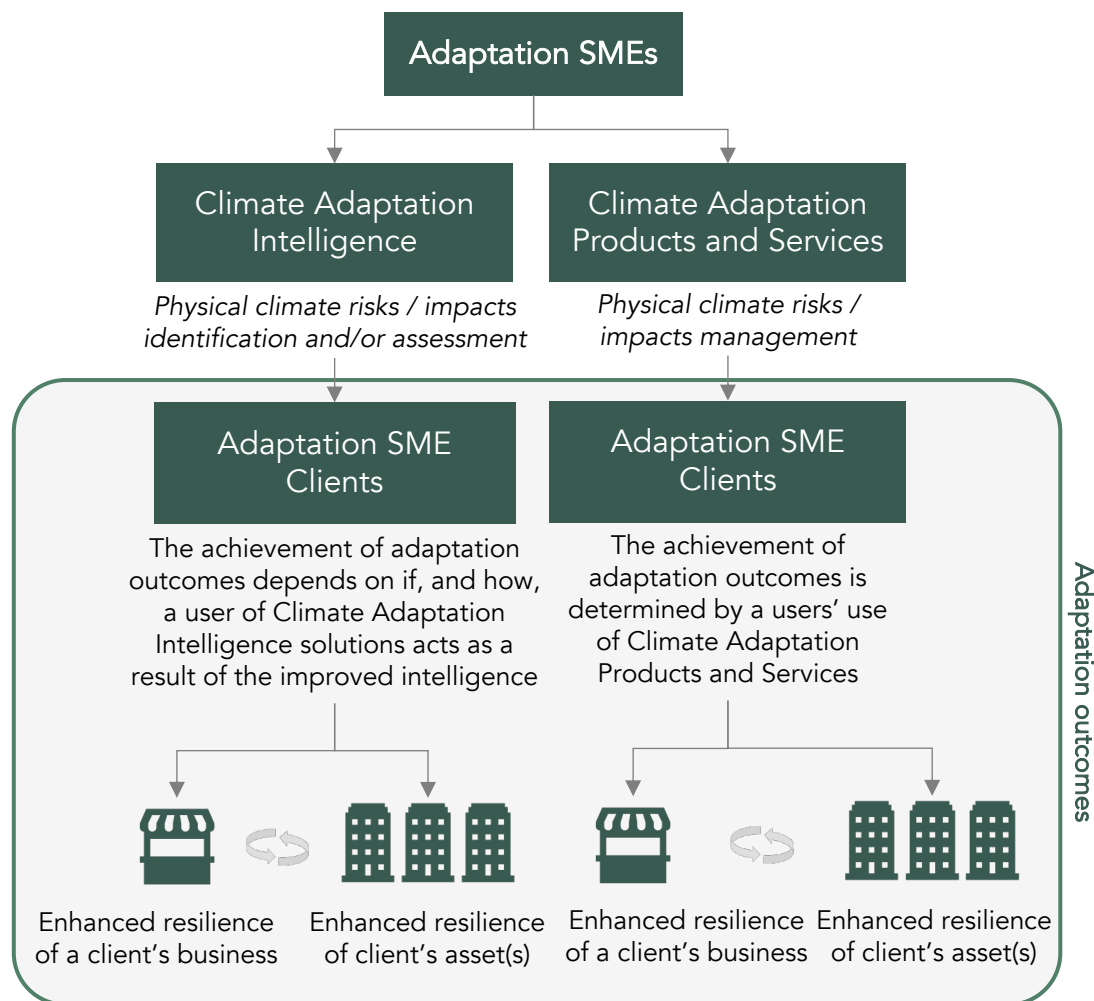
¹ It is worth noting that significant progress and contributions have been made to date on this matter. See e.g., Joint MDBs/IDFC (2019), *A Framework and Principles for Climate Resilience Metrics in Financing Operations*; EU Taxonomy for sustainable activities (2019); EBRD and GGCA (2018), *Advancing TCFD guidance on physical climate risks and opportunities*; EBRD (2018), *Implementing the EBRD Green Economy Transition - Technical Guide for Consultants*; TCFD (2017). Source: Joint MDBs/IDFC (2019), *A Framework and Principles for Climate Resilience Metrics in Financing Operations*.

² Spearman and MacGray (2011); Leiter and Pringle (2018); Leiter et al. (2019)

Evaluating the contribution of Taxonomy-aligned SMEs to adaptation: key considerations

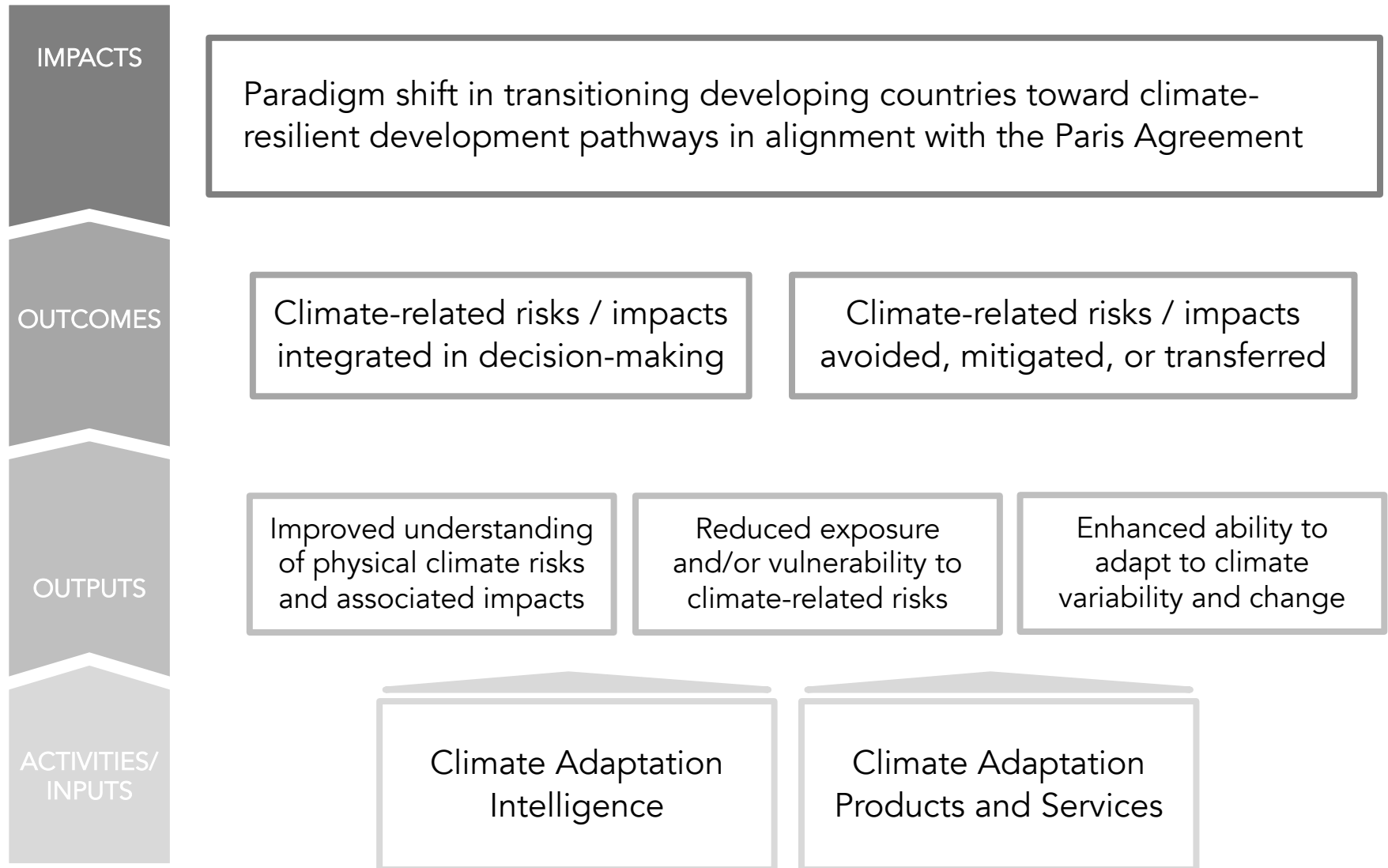
- + Evaluating the incremental contribution of Adaptation SMEs to climate adaptation outcomes requires the following considerations:

- + The distinctive contribution to adaptation that Climate Adaptation Intelligence vs. Climate Adaptation Products and Services can deliver along the results chain
- + The level of the results chain at which adaptation outcomes can manifest i.e., at an Adaptation SMEs' client business level (organization-wide) and/or an asset(s) level
- + The contribution that tackling system barriers to adaptation can deliver to the wider system¹ reached by an adaptation solution at different points in time
- + SMEs' ability to enhance user awareness and capacity
- + Adaptation SMEs' ability to measure and report on their incremental contribution to adaptation → A measurement and reporting approach for SMEs should seek to be practical, consistent, comparable and not overly burdensome



¹ According to the EU Taxonomy, "systemic adaptation" activities aims to "actively reduce vulnerability and build resilience of a wider system, or systems, such as a community, ecosystem, or city". According to the Joint-MDBs/IDFC (2019), "system" refers to the "wider context e.g., livelihood, transport and logistics, supply chain, value chain, information and communication, market, ecology".

Adaptation SME contributions to adaptation along the results chain



OUTCOMES

- + The great heterogeneity and diversity of potential physical climate-related risks and responses, and the wide range of solutions potentially offered by Adaptation SMEs, call for the consideration of a wide set of metrics.¹
- + Considering the level of the results chain at which adaptation outcomes can manifest (see slide 40), Adaptation SMEs' incremental contribution to adaptation could be measured in terms of, for example, enhanced access to adaptation technologies (e.g. # of adaptation-relevant technologies sold), empowerment of women via enhanced access to adaptation technologies (# of Adaptation SMEs' clients that are women), or technology performance (e.g. estimated improvements in agricultural productivity).

Climate Adaptation Intelligence-related metrics

\$US total Climate Value at Risk estimated
No. of organizations / individuals supported in integrating climate-related considerations in decision-making
No. of organizations / individuals supported in disclosing climate-related financial risks

*Climate Adaptation Products & Services-related metrics*²

↑ water availability	Clients Households Provided New Access; Water (L) Generated; Water (L) Saved
↑ energy availability/reliability	Time/Value of Avoided Power Downtime; Renewable-based Backup Capacity Generation (MWH); Area (Absolute/%) of Transmission Line Undergrounded
↑ agricultural potential	Average agricultural yield; Area of Degraded; Land (hectares) Reforested / Restored
↓ weather-related disruption	Value of assets covered; # of customers served by the Company's data and analytics
↓ weather-related damage	Gross Incurred Claim; Value of Extended Asset Life

¹ To enhance harmonization in impact reporting, the selection of indicators should take into due consideration existing impact reporting frameworks such as ICMA Group (2020), [Harmonized Framework for Impact Reporting](#).

² Adapted from EBRD (2018), [Implementing the EBRD Green Economy Transition - Technical Guide for Consultants](#).

5. Next steps

- + Road-test the Taxonomy to determine whether it requires further refinement
- + Advance the development of the results framework
- + Actively pursue dissemination, uptake and harmonization of the Taxonomy by engaging with relevant initiatives, networks and forums such as:

Initiatives	+ International Platform on Sustainable Finance
Networks	<ul style="list-style-type: none"> + EuroClima + GARI – Global Adaptation and Resilience Investment Working Group* + Global Adaptation Network + Network of Financial Centers for Sustainability (FC4S) + Private-sector led Coalition for Climate Resilient Investment + USAID SERVIR program regional hubs + WBCSD
Events	<ul style="list-style-type: none"> + Innovate4Climate + London Climate Action Week + New York Climate Action Summit + UN COP 26

* GARI could potentially support uptake of the taxonomy in the following ways: developing implementation guidance, launch a climate adaptation impact metrics working group, support testing of the taxonomy against member investment portfolios, etc.

ANNEXES

ANNEX A.

Definitions, principles, and criteria

Source	Definition
<p>Climate Bonds Initiative (2019) Climate Resilience Principles</p>	<ul style="list-style-type: none"> + Climate resilience investments improve the ability of assets and systems to persist, adapt and/or transform in a timely, efficient, and fair manner that reduces risk, avoids maladaptation, unlocks development and creates benefits, including for the public good, against the increasing prevalence and severity of climate-related stresses and shocks. Depending on the intent of the investment, resilience investments can be categorized as: <ul style="list-style-type: none"> – <i>Asset-focused</i>: to maintain or enhance the resilience of an asset or activity to climate change, specifically to ensure that the asset or activity's performance is fit-for-purpose over its design lifespan – <i>System-focused</i>: to deliver climate resilience benefits to the broader system.
<p>EU Technical Expert Group on Sustainable Finance (2020). Taxonomy Report: Technical Annex (2020)</p>	<p>An economic activity shall be considered to contribute substantially to climate change adaptation where that:</p> <ul style="list-style-type: none"> a) Economic activity includes adaptation solutions that either substantially reduce the risk of adverse impact or substantially reduces the adverse impact of the current and expected future climate on that economic activity itself without increasing the risk of an adverse impact on other people, nature and assets; or where b) Economic activity provides adaptation solutions that [...] contribute substantially to preventing or reducing the risk of adverse impact or substantially reduces the adverse impact of the current and expected future climate on other people, nature or assets, without increasing the risk of an adverse impact on other people, nature and assets <p>Economic activities can contribute to adaptation objectives in two different ways:</p> <ol style="list-style-type: none"> 1. <i>Adapted activities</i>: an economic activity is adapted to all material physical climate risks identified for the economic activity to the extent possible and on a best effort basis; and/or 2. <i>Activities enabling adaptation of an economic activity</i>: the activity reduces material physical climate risk in other economic activities and/or addresses systemic barriers to adaptation and is itself also adapted to physical climate risks.
<p>IPCC (2018)</p>	<ul style="list-style-type: none"> + Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects + Resilience: The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function identity and structure while also maintaining the capacity for adaptation, learning and transformation

Source	Definition
Joint-MDB/IDFC (2019)	Climate resilience is strengthening a system to withstand climate-related shocks or stressors. [...] Climate resilience is the capacity of a system to cope with, or recover from, those effects, while retaining the essential components of the original system.
UNFCCC (2014) ; UNFCCC (2005), Report on the seminar on the development and transfer of technologies for adaptation to climate change	Adaptation technology can be defined as the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the [impacts] of climate change
IPCC Special Report on Methodological and Technological Issues in Technology Transfer (2000)	<p><i>Technology:</i> The practical application of knowledge to achieve particular tasks that employs both technical artefacts (hardware, equipment) and (social) information ('software', know-how for production and use of artefacts) (IPCC AR4, 2007).</p> <p>Technologies that can be deployed to assist in any of the four steps that comprise the process of adaptation to climate change</p> <ul style="list-style-type: none"> + Information development and awareness raising + Planning and design + Implementation + Monitoring and evaluation
Climate Technology Centre & Network	<p>Any equipment, techniques, practical knowledge and skills needed for adapting to climate change</p> <ul style="list-style-type: none"> + Hardware, software and 'orgware' + Traditional, modern, high tech

Source	Definition
European Commission (2015)	Climate services refers to the transformation of climate-related data – together with other relevant information – into customized products such as projections, trends, economic analysis, counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large
European Research Area for Climate Services	We consider Climate Services as the user-driven development, translation and transfer of climate knowledge to researchers and decisionmakers in policy and business. This includes knowledge for understanding the climate, climate change and its impacts, as well as guidance in the use of climate knowledge.
Global Framework for Climate Services ¹ (WMO)	Climate services provide climate information to help individuals and organizations make climate smart decisions. Climate services equip decision makers in climate-sensitive sectors with better information to help society adapt to climate variability and change.
IPCC (2018)	Climate services refers to information and products that enhance users' knowledge and understanding about the impacts of climate change and/or climate variability so as to aid decision-making of individuals and organizations and enable preparedness and early climate change action. Products can include climate data products
Market Research for a Climate Services Observatory (MARCO) (2018)	Acknowledging the difficulties associated to defining what constitutes a "Climate Service", MARCO project's taxonomy includes transactions listed as "Climate Services" by those providing the service. MARCO project highlights the core competencies of climate services i.e., "[...] Information regarding climate allows the user to prepare for the weather they are likely to experience as a result. These services include data from national and international databases on rainfall, temperature, wind, soil moisture and ocean conditions on the simplistic side, to more complicated maps, risk and vulnerability analyses, assessments and long-term forecasts".
World Meteorological Organization (based on Hellmuth M.E. et al., 2011).	A climate service is a decision aide derived from climate information that assists individuals and organizations in society to make improved ex-ante decision-making. A climate service requires appropriate and iterative engagement to produce a timely advisory that end-users can comprehend and which can aid their decision-making and enable early action and preparedness. Climate services need to be provided to users in a seamless manner and, most of all, need to respond to user requirements.

¹ Note: The Global Framework for Climate Services (GFCS) is a UN-led initiative spearheaded by WMO that was established in 2009 to guide the development and application of science-based climate information and services in support of decision-making in climate sensitive sectors. Thirteen heads of state or government, 81 ministers and 2500 scientists unanimously agreed to develop the GFCS. Source: GFCS [website](#).

Source	Guiding principles and screening criteria
EU Technical Expert Group on Sustainable Finance (2020), Taxonomy Report: Technical Annex (2020)	<p>Guiding principles for substantial contributions to climate change adaptation:</p> <ol style="list-style-type: none"> 1. The economic activity reduces all material physical climate risks to the extent possible and on a best effort basis. 2. The economic activity does not adversely affect adaptation efforts by others. 3. The economic activity has adaptation-related outcomes that can be defined and measured using adequate indicators. <p>Screening criteria for 'adapted activities'</p> <p>A1. Reducing material physical climate risks - The economic activity must reduce all material physical climate risks to that activity to the extent possible and on a best effort basis.</p> <p>A2. Supporting system adaptation - The economic activity and its adaptation measures do not adversely affect the adaptation efforts of other people, nature and assets.</p> <p>A3. Monitoring adaptation results - The reduction of physical climate risks can be measured.</p> <p>Screening criteria for an activity enabling adaptation:</p> <p>The economic activity reduces material physical climate risk in other economic activities and/or addresses systemic barriers to adaptation. Activities enabling adaptation include, but are not limited to, activities that:</p> <ol style="list-style-type: none"> a) Promote a technology, product, practice, governance process or innovative uses of existing technologies, products or practices (including those related to natural infrastructure); or, b) Remove information, financial, technological and capacity barriers to adaptation by others. <p>The economic activity reduces or facilitates adaptation to physical climate risks beyond the boundaries of the activity itself. The activity will need to demonstrate how it supports adaptation of others through</p> <ul style="list-style-type: none"> + An assessment of the risks resulting from both current weather variability and future climate change, including uncertainty, that the economic activity will contribute to address based on robust climate data; + An assessment of the effectiveness of the contribution of the economic activity to reducing those risks, taking into account the scale of exposure and the vulnerability to them <p>[In the case of infrastructure linked to an activity enabling adaptation, that infrastructure must also meet the screening criteria A1, A2 and A3 of the screening criteria for 'adapted activities']</p>

Source	Screening Principles
<p>Climate Bonds Initiative (2019) Climate Resilience Principles</p>	<ol style="list-style-type: none"> 1. <i>Framing Principle</i>: Understanding the context by clearly defining boundaries and interdependencies with the systems of which it is a part <ul style="list-style-type: none"> + Assets and activities being invested in must have clearly defined boundaries and identify interdependencies for assessing climate risks and resilience impacts 2. <i>Design Principle</i>: asset or activity being invested in does substantially mitigate climate risks to the asset or activity itself and/or the system it is part of. <ul style="list-style-type: none"> + Addressing physical climate risks <ul style="list-style-type: none"> – Physical climate risk assessment – Physical climate risk reduction measures for the identified climate resilience risks + Addressing resilience benefits <ul style="list-style-type: none"> – Resilience benefit assessment – Climate mitigation trade-off assessment 3. <i>On-going management principle</i>: on-going monitoring & evaluation to ensure resilience actions remain in step with evolving climate hazards, exposure and vulnerability, and changing opportunities and needs for resilience benefits

ANNEX B.

Classification approaches

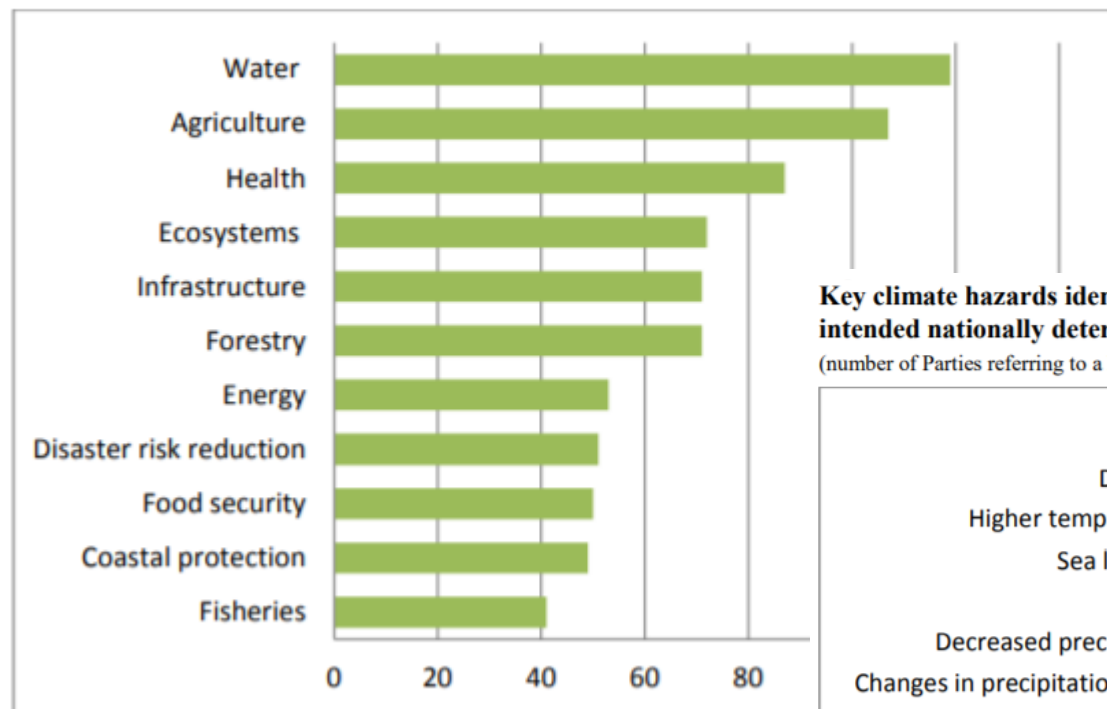
Overview of classification approaches adopted by existing taxonomies, frameworks, and methodologies



Initiative	Objective	Segmentation
Nationally Determined Contributions (NDCs)	Guide climate actions towards areas with the potential of delivering the greatest impact	Policy-driven sectoral segmentation to steer adaptation action in priority areas
UNFCCC Climate Technology Centre & Network (CTCN, 2017)	Enhance the development and transfer of technologies to developing countries	Policy-driven to help identify solutions to climate-related hazards
Global Framework for Climate Services (GFCS WMO)	Improve the quality and quantity of Climate Services worldwide, particularly in developing countries	Policy- and business-driven high-level segmentation by priority areas
European Market for Climate Services (EU-MACS, 2017)	Analyze the commercial and non-commercial Climate Services market	Policy- and business-driven segmentation based on both commercial and non providers of climate services
Climate Knowledge Hub	Map and profile climate service providers	Policy and business-driven segmentation aimed at helping users to identify the Climate Service provider(s) that best meet their needs
Market Research for a Climate Services Observatory (MARCO, 2018)	Analyze the commercial Climate Services market	Business-driven segmentation of Climate Services based on typology (type of data platform & service) and based on those sectors/industries in which they are used
EU Taxonomy for sustainable activities (2020)	Drive capital towards economic activities substantially contributing to adaptation, while avoiding significant harm to the other environmental objectives	NACE for industry classification ¹ and an indicative framework for classification of climate-related hazards to guide users to consider the most salient physical risks when mapping the sensitivities of a given sector (see next slide). Recognizing that climate change will affect all sectors of an economy and all sectors must adapt to its impacts globally, the EU Taxonomy provides additional guidance for those sectors that (i) are among the most vulnerable to the negative effects of climate change in Europe; (ii) represent a large share of GVA and employment, allow for testing of the adaptation taxonomy approach in natural resource-based sectors, service sectors and asset-based sectors.
Task Force on Climate-Related Financial Disclosures (TCFD, 2017)	Enhance climate-related financial disclosures to enable the integration of climate risks and opportunities in decision-making	Business-oriented focus on those sectors with the highest likelihood of climate-related financial impacts
Climate Bonds Initiative (2019) Climate Resilience Principles	Determine when the intended use of proceeds may be deemed to contribute to reducing physical climate risk and improving climate resilience	None (The principles provide a framework within which developing sector-specific climate resilience criteria)

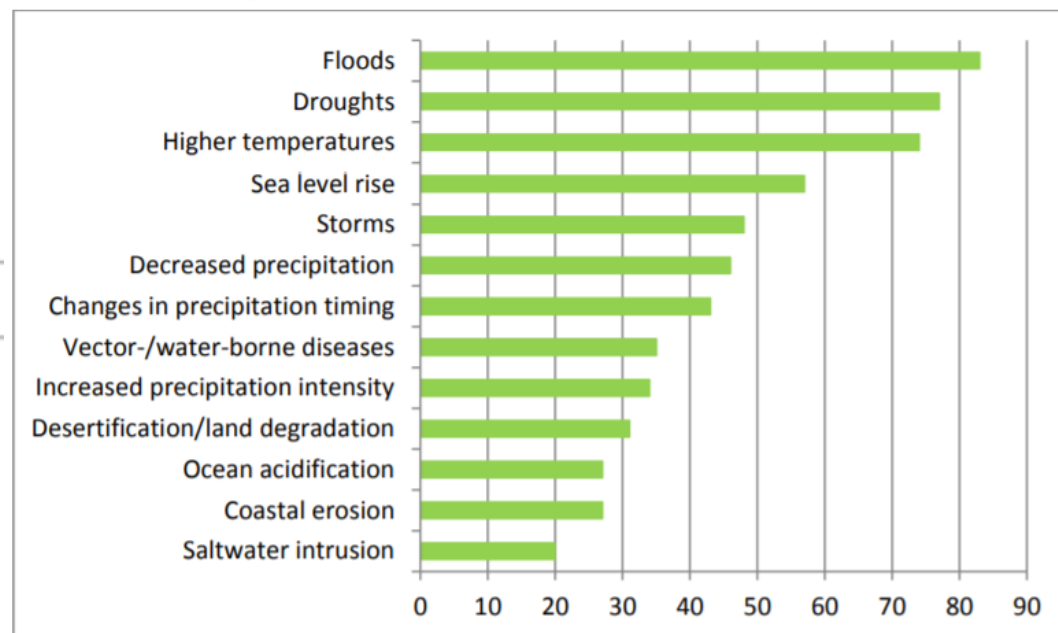
Priority areas and sectors for adaptation actions identified in the adaptation component of the communicated intended nationally determined contributions

(number of Parties referring to area or sector)



Key climate hazards identified in the adaptation component of the communicated intended nationally determined contributions

(number of Parties referring to a hazard)



A policy-driven classification

Taxonomy of the UNFCCC Climate Technology Centre & Network

- + The Climate Technology Centre & Network (CTCN), whose mandate is to “stimulate technology cooperation and enhance the development and transfer of technologies to developing country Parties at their request”, developed a taxonomy of adaptation technologies defined as: *“Any equipment, techniques, practical knowledge and skills needed for adapting to climate change*

Sector	Technology Groups		Technology Examples	
Early Warning and Environmental Assessment	<ul style="list-style-type: none"> Remote sensing & GIS Hazard mapping Early warning system Monitoring systems 	<ul style="list-style-type: none"> Improved weather forecasting & hydrometeorological networks 	<ul style="list-style-type: none"> Seasonal to interannual weather forecast Disaster risk assessment tools Hazard mapping solutions 	<ul style="list-style-type: none"> Flood hazard mapping Early Warning Systems Communication Flood forecasting systems ...
Agriculture and Forestry	<ul style="list-style-type: none"> Terrestrial ecosystems management Agro-forestry, Silviculture & Mixed farming Seed, grain & food storage 	<ul style="list-style-type: none"> Increasing crop resilience and productivity Livestock management Land management training 	<ul style="list-style-type: none"> Crop storage Precision agriculture Soilless agriculture Improved cultivation techniques 	<ul style="list-style-type: none"> Aeroponic seed production ...
Water	<ul style="list-style-type: none"> Water efficiency and demand management Adaptation planning Water augmentation (increasing capture and storage of surface run-off) Hydropower Water Pollution Riverine flood protection 	<ul style="list-style-type: none"> Urban storm water management Water storage Use of alternative water sources Integrated planning Limiting nutrient leakage Water allocation 	<ul style="list-style-type: none"> Hazard mapping seasonal to interannual weather forecast Disaster risk assessment tools Irrigation efficiency and information systems Leakage management in piped systems Water efficiency in industry 	<ul style="list-style-type: none"> Open source climate data and tools Climate change vulnerability assessment Downscaling of climate model projections Embedding climate variability in hydropower design ...
Human health	<ul style="list-style-type: none"> Emergency medical services Advanced IT systems in the health sector 	<ul style="list-style-type: none"> Public health services Vaccination programs Vector-borne disease 	<ul style="list-style-type: none"> Disease surveillance systems E-Health Rapid diagnostic tests 	<ul style="list-style-type: none"> Malaria protection and prevention programs ...
Infrastructure & urban planning	<ul style="list-style-type: none"> Ground surface material Sewerage infrastructure Land use in human settlements Building design and material Urban design and spatial planning 	<ul style="list-style-type: none"> Grid resiliency Building construction Water supply infrastructure Urban planning Building codes Resilient transport systems 	<ul style="list-style-type: none"> Engineered cementitious composite (ECC) Urban infrastructure development Warm-mix asphalt Resilient railway systems 	<ul style="list-style-type: none"> Resilient road systems Urban infrastructure development Elevated buildings
Coastal zones	<ul style="list-style-type: none"> Retreat Accommodation Integrated coastal zone management 	<ul style="list-style-type: none"> Protection (hard & soft engineering) 	<ul style="list-style-type: none"> Flood warning systems Coastal setbacks Managed realignment Flood and cyclone shelters 	<ul style="list-style-type: none"> Floating houses Management of seagrass beds ...
Marine and fisheries	<ul style="list-style-type: none"> Active motion-dampening systems for marine port Seaweed farming Marine protected areas 	<ul style="list-style-type: none"> Fisheries management Artificial reefs Aquaculture management 	<ul style="list-style-type: none"> Active motion-dampening systems for marine ports Seaweed farming Marine protected areas 	<ul style="list-style-type: none"> Fisheries management Artificial reefs Aquaculture management ...

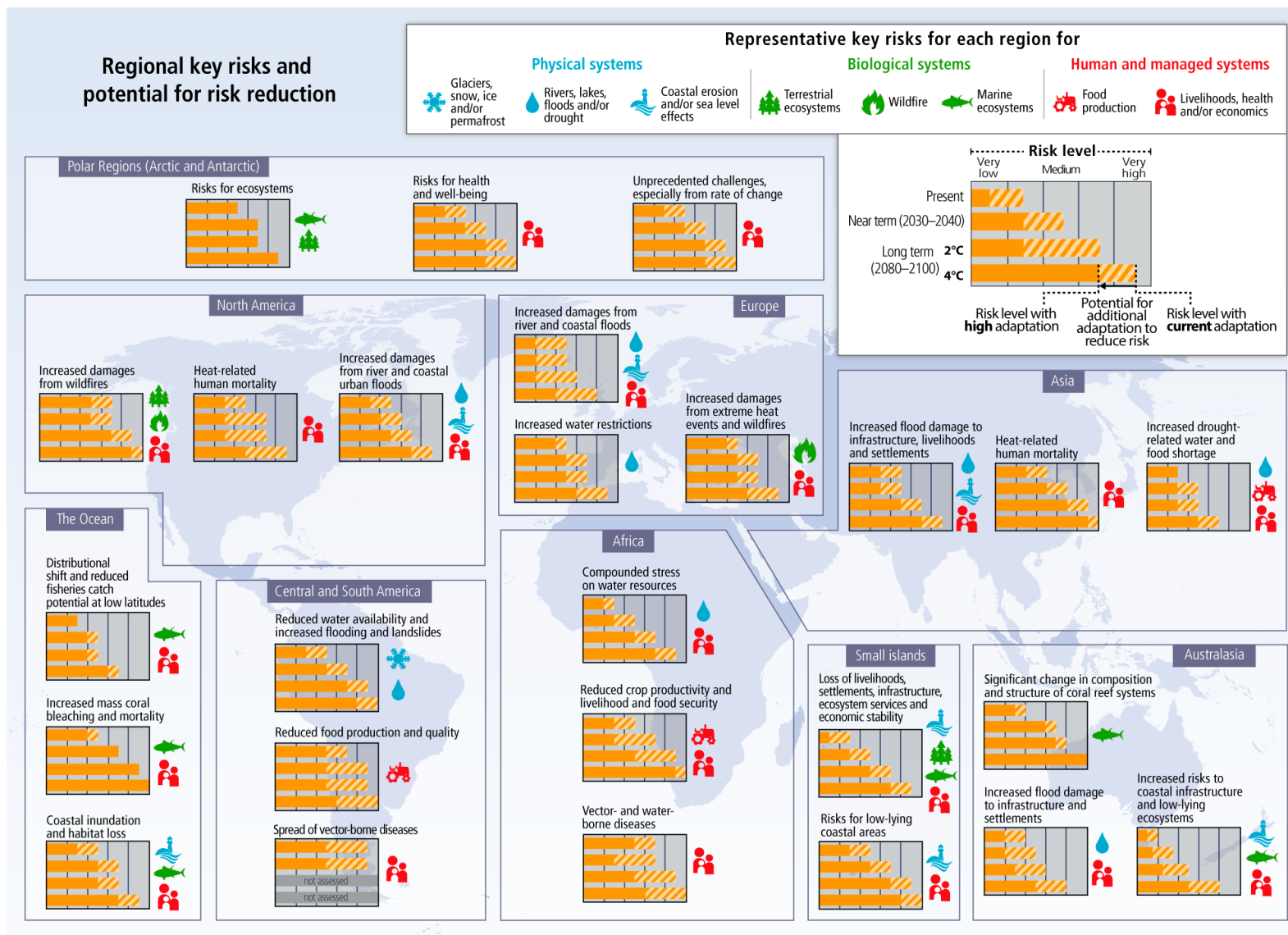
Source: CTCN (2017) | [CTCN Taxonomy – Adaptation Sector](#); CTCN (2016), [CTCN: Mandate, services offered, and operative lessons learned](#).

A scientific/policy-driven classification

Key economic sectors analyzed by IPCC WG II AR5

Sectors	
Energy + Demand + Supply + Transport and Transmission of Energy	Other Primary and Secondary Economic Activities + Crop and Animal Production + Forestry and Logging + Fisheries and Aquaculture + Mining and Quarrying + Manufacturing + Construction and Housing
Water Services + Water Infrastructure + Municipal and Industrial Water Supply + Wastewater + Irrigation + Nature Conservation + Water Management and Allocation	Transport + Roads + Rail + Pipeline + Shipping + Air
	Recreation and Tourism
	Insurance and Financial Services
Health	

Regional map of representative key climate-related risks by IPCC AR5



Sector	Rationale
Agriculture & Food Security	<p>In an era of rapid population growth, food security remains a major concern. Agriculture is vulnerable not only to market fluctuations but also to climate variability and climate change and natural hazards.</p> <p>Climate services can improve delivery and provides a set of actions that will improve, uptake and use climate services in this sector</p>
Disaster Risk Reduction	<p>Most natural hazards are caused by weather and climate.</p> <p>User-friendly climate services can help countries and communities build greater resilience against floods, droughts, storms and other hydrometeorological hazards.</p>
Energy	<p>Energy generation and planning of operations are markedly affected by meteorological events and energy systems are increasingly exposed to the vagaries of weather and climate affecting both the availability and energy demand.</p>
Health	<p>Climate variability and climate change have important repercussions on public health. Temperature and rainfall conditions influence the spread of communicable diseases while extreme weather events cause injury and death.</p> <p>Demand-driven climate services can empower the health community to save lives.</p>
Water	<p>The amount and availability of water is strongly influenced by climate variability and change. Seasonal climate outlooks and other climate services and products can greatly improve water supply management</p>

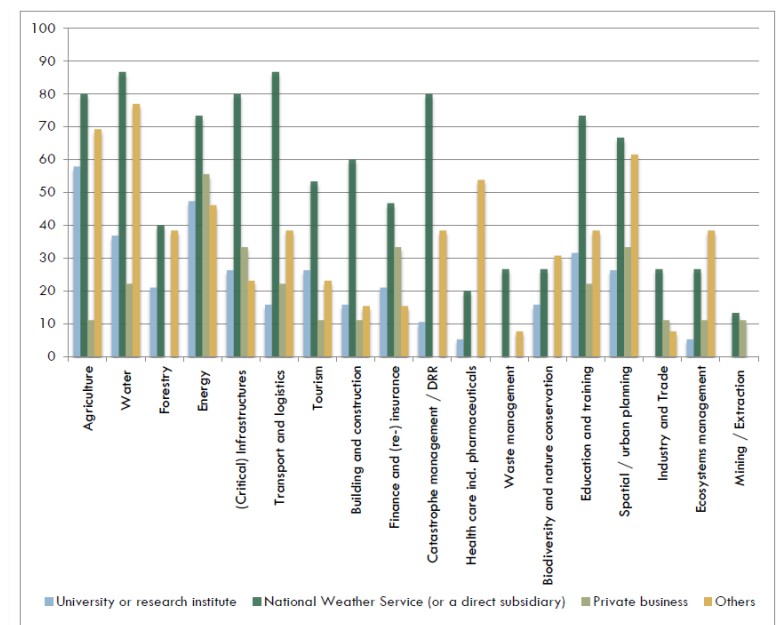
A policy- and business-driven classification

A market classification of Climate Services | EU-MACS

Sectors	
Agriculture	Catastrophe management / DRR
Water	Health care incl. pharmaceuticals
Forestry	Waste management
Energy	Biodiversity and nature conservation
(Critical) Infrastructures (incl. energy and water supply; excl. roads, rails and waterways)	Education and training
Transport and logistics	Spatial / urban planning
Tourism	Industry and trade
Building and construction	Ecosystems management
Finance and (re-) insurance	Mining / extraction

Climate Services Typologies	
Advisory services, risk assessment and decision support tools	Operations (collection and provision of raw data)
Data management, incl. calibrated data sets, data archiving, data certification	Processed data, incl. re-analysis
Measurements, incl. instruments and technologies for measurements and calibration	Publications, e.g., synthesis and assessments, guidance documents, manuals
Modelling, incl. climate, impacts and socio-economics	

- + Agriculture, water and energy are the sectors primarily addressed by the commercial and non-commercial Climate Service providers participating to the EU-MACS survey
- + Energy is the sector mostly targeted by private providers of Climate Services



A policy- and business-driven classification

A user-driven profiling of Climate Service providers | Climate Knowledge Hub

Sector targeted		Key competencies
Agriculture	(Critical) Infrastructures	Fundamental research
Water	Industry and trade	Applied research / technology
Forestry	Spatial / urban planning	Consulting
Tourism	Finance and insurance	Education / Capacity Building
Energy	Nutrition	
Building and construction	Waste management	
Health	Social structures / governance	
Biodiversity	Education	
Ecosystems (incl. soil)	Other	
Transport		

Thematic focus	
Climate System	Disaster Risk Reduction
Impacts of climate change	Geo-engineering
Vulnerability to climate change	Transition to low-carbon economy
Adaptation to climate change	Societal transformation to sustainability
Climate mitigation	Biodiversity Conservation

Source: Adapted from [Climate Knowledge Hub](#) (i.e., not displaying the following categories as deemed covered by the “institution Type” section of the Hub profiling “researchers, consultancies, small businesses, practitioner e.g., architects; public decision makers/politicians, corporations”).

The Climate Knowledge Hub mapping is part of a European project aimed at establishing an EU Research Area for Climate Services covering 18 countries.

A business-driven classification

Sectors demanding commercial Climate Services | MARCO



Sectors	
Agriculture	Manufacturing
Biotech	News Publishing & Journalism
Built Environment	Operational Services
Business Services	Pharmaceuticals
Communications	Public & Charitable Bodies
Defense	Renewable Energy
Education & Training	Research & Development
Exploration	Retailing & Wholesale
Food & Drink (from post-agricultural to retail sales)	Tourism & Leisure
Forestry & timber (incl. processing)	Utilities (incl. distribution and recycling of water)
Health Care (incl. hospitals)	Processing Industry Not Elsewhere Classified
Hospitality (incl. hotels and restaurants)	Civil Engineering Sector Not Elsewhere Classified
Legal & Financial	Other Industries not Elsewhere Classified
Logistics (incl. air, land and sea travel of people and goods)	

+ MARCO project identified a wide variety of sectors as users of Weather and Climate Services

A business-driven classification

Uses of commercial weather & climate services within various sectors | MARCO

Sectors	
Corporate governance	Futures Market Data
Insurance purposes	Humanitarian Relief planning
Corporate Planning Long Term	Exploration Planning
Estates Locational Planning	Installation Redundancy Planning
Content for Information-Giving Services	Regulatory Services (Land Cover)
Forward Crop Planning	Forensic Services
Investment Planning	Border Management & Planning
Infrastructure Planning	Long-Term Operations Planning
Service Provision Planning	Long Range Product Planning
Major Capital Project Planning	Educational
Irrigation & Drainage Planning	Resource Planning
Research Programs	Environmental Planning
Disaster Recovery Planning	
Health & Safety Services	

- + MARCO project identified that:
 - + Corporate Governance (accountability), Insurance, Corporate Planning and Investment Planning were the most frequent usages of Weather and Climate Services
 - + Forward crop planning, exploration planning (incl. water and civil engineering), broader management (legal, defense, public services and general consultancy) were the most specific uses

Service type	Description
Measurement	Instruments and technologies for measurement and calibration for global weather, climate and climate change applications.
Operation	Collection and provision of raw data for global weather, climate and climate change applications.
Modelling	Modelling of data, both certified and non-certified for global weather, climate and climate change.
Data Management	Provision of calibrated data sets, data archiving, data certification and data sales for global weather, climate and climate change applications.
Processing & Re-Analysis	Provision of data analysis and retrieval services including data mining tools, for global weather, climate and climate change.
Advisory Services	Advisory, risk assessment and decision support tools e.g. risk assessment for the long-term location of a hydropower plant.
Other consulting	General consulting services include consulting services about corporate responses to climate change e.g., mapping corporate's and their supply chain's exposure to physical climate risks.
Publications	General publication of analysis findings for global weather, climate and climate change i.e., the assembly of publications on climate forecasts based on data and analysis for both private and public sector organizations.

Source: The table above presents the classification provided by MARCO (2018), *Final definition, Taxonomy and Report*. (The same terminology is also applied in EU-MACS). MARCO project's categorization of climate services refers to both Weather and Climate Services. From a user perspective, Weather Services and Climate Services are two points on a single continuum and both are typically required. The difference between two relates to the duration of time the service relates to i.e., short-term vs. longer-term. EU-MACS noted there are further categories of climate services that are not reflected in the terminology outlined in the table above e.g., capacity building and training.

	Temperature-related	Wind-related	Water-related	Solid mass-related
Chronic	Changing temperature (air, freshwater, marine water)	Changing wind patterns	Changing precipitation patterns and types (rain, hail, snow/ice)	Coastal erosion
	Heat stress		Precipitation and/or hydrological variability	Soil degradation
	Temperature variability		Ocean acidification	Soil erosion
	Permafrost thawing		Saline intrusion	Solifluction
			Sea level rise	
			Water stress	
Acute	Heat wave	Cyclone, hurricane, typhoon	Drought	Avalanche
	Cold wave/frost	Storm (including blizzards, dust and sandstorms)	Heavy precipitation (rain, hail, snow/ice)	Landslide
	Wildfire	Tornado	Flood (coastal, fluvial, pluvial, ground water)	Subsidence
			Glacial lake outburst	

+ The Technical Expert Group (TEG) developed a classification of climate-related hazards to guide the user to consider the most salient physical risks when mapping the sensitivities of a given sector. It did not include all secondary hazards resulting from climate-related hazards. It however advised to assess the risk of such secondary hazards and consider measures to address them for each economic activity

Classification of climate-related hazards

Example of sectoral climate sensitivity matrix | EU Taxonomy

+ Agriculture and Forestry

Economic Activity			Temperature-related							Wind-related			Water-related										
Sector: Agriculture, Forestry and Fishing			Acute			Chronic				Acute			Chronic	Acute				Chronic					
NACE CODE	Parent	This sector includes ...	Heat Wave	Cold Wave / Frost	Wildfire	Changing Temperature (Air, Freshwater, Marine Water)	Heat Stress	Temperature Variability	Permafrost Thawing	Cyclones, Hurricanes, Typhoons	Storms (Blizzards, Dust Storms, Sand Storms)	Tomadoes	Changing Wind Patterns	Drought	Heavy Precipitation (Rain, Hail, Snow / Ice)	Flood Fluvial, Pluvial, Groundwater) (Coastal,	Glacial Lake Outburst	Changing Precipitation Patterns and Types (Rain, Hail, Snow / Ice)	Precipitation, Hydrological Variability	Ocean Acidification	Saline Intrusion	Sea Level Rise	Water Stress
1.1	1	Growing of non-perennial crops																					
1.11	1.1	Growing of cereals (except rice), leguminous crops and oil seeds																					
1.12	1.1	Growing of rice																					
1.13	1.1	Growing of vegetables and melons, roots and tubers																					
1.14	1.1	Growing of sugar cane																					
1.15	1.1	Growing of tobacco																					
1.16	1.1	Growing of fibre crops																					
1.19	1.1	Growing of other non-perennial crops																					
1.2	1	Growing of perennial crops																					
1.21	1.2	Growing of grapes																					
1.22	1.2	Growing of tropical and subtropical fruits																					

Source: EU Technical Expert Group on Sustainable Finance (2020), Taxonomy Report: Technical Annex (page 28, Table 5).

A business-oriented classification

Sectors with the highest likelihood of climate-related financial impacts | TCFD

Sector	
Agriculture, Food, & Forest Products <ul style="list-style-type: none">- Beverages- Agriculture- Packaged Foods and Meats- Paper and Forest Products	Energy <ul style="list-style-type: none">- Oil and Gas- Coal- Electric Utilities
Materials and Buildings <ul style="list-style-type: none">- Metals and Mining- Chemicals- Construction Materials- Capital Goods- Real Estate Management and Development	Transportation <ul style="list-style-type: none">- Air Freight- Passenger Air Transportation- Maritime Transportation- Rail Transportation- Trucking Services- Automobiles and Components

- + The TCFD determined this classification based on three factors most likely to be affected by both transition and physical climate risks: GHG emissions, energy usage, and water usage.
- + The TCFD validated its approach through:
 - + Consultations soliciting more than 200 responses which resulted in the ranking of Energy, Utilities, Materials, Industrials and Consumer Staples / Discretionary as the Global Industry Classification Standard (GICS) sectors most important for disclosure guidelines to cover
 - + Review of sector-specific disclosure guidance documents (CDP, GRESB, etc.)
 - + Review of IPCC WG II AR5 on key economic sectors
 - + Review of grey literature providing information on which industries have the highest exposures to climate change e.g., IEA, Moody's, S&P Global Ratings, WRI/UNEPFI

Source: TCFD (2017), *Recommendations of the Task Force on Climate-related Financial Disclosures | Final Report*.

Note: As stated in TCFD (2017), these four groups and their associated industries are intended to be indicative of the economic activities associated with these industries rather than definitive industry categories.

A business-driven classification

Sensitivity to climate-related hazards by industry

+ The matrix summarizes sensitivities to physical climate hazards by industry group

GICS sector	GICS industry group	Storms and cyclones	Extreme rainfall and flood	Extreme heat	Variability in precipitation	Variability in temperature	Water stress	Sea-level rise	Other climate hazards
Consumer discretionary	Automobiles and components	High	High	High	Medium	High	Medium	High	Degraded air quality
	Consumer durables and apparel	High	High	High	Medium	High	Medium	High	Degraded air quality
	Consumer services	High	High	Low	Medium	Medium	Medium	High	
	Media	High	High	Low	Low	Low	Low	High	
	Retailing	High	High	Low	Low	Low	Low	High	
Consumer Staples	Food and staples retailing	High	High	Low	Medium	Medium	Medium	High	
	Food, beverage and tobacco	High	High	Medium	High	High	High	High	Soil degradation, ocean acidification
	Household and personal products	High	High	Medium	Medium	High	Medium	High	
Energy	Energy	High	High	High	Medium	High	Medium	High	Ice melt, permafrost melt
Financials	Banks	High	High	Low	Low	Low	Low	High	

GICS sector	GICS industry group	Storms and cyclones	Extreme rainfall and flood	Extreme heat	Variability in precipitation	Variability in temperature	Water stress	Sea-level rise	Other climate hazards
Financials	Diversified financials	High	High	Low	Low	Low	Low	High	
	Insurance	High	High	Medium	Medium	Medium	Medium	High	Hail storms, landslides, wildfires
Health care	Healthcare equipment and services	High	High	High	Low	Low	Medium	High	Wildfires, humidity, degraded air quality
	Pharmaceuticals, biotechnology and life sciences	High	High	High	Medium	High	Medium	High	
Industrials	Capital goods	High	High	High	High	Medium	High	High	
	Commercial and professional services	High	High	Low	Low	Low	Low	High	
	Transport	High	High	Medium	Low	Low	Low	High	Permafrost melt, ice melt
Information technology	Semi-conductors	High	High	High	Low	High	Medium	High	
	Software and Services	High	High	Low	Low	Low	Low	High	
	Technology hardware and equipment	High	High	High	Low	High	Medium	High	
Materials	Materials	High	High	High	High	High	High	High	
Real estate	Real estate	High	High	Low	Low	Low	Low	High	
Telecommunications services	Telecommunications services	High	High	Low	Low	Low	Low	High	
Utilities	Utilities	High	High	High	High	High	High	High	Wildfires

Source: Four Twenty Seven (© Four Twenty Seven 2017).

Note: The sensitivity matrix is indicative only. It is not to be used as a substitute for a materiality assessment for any individual corporation.
Source: EBRD and GGCA (2018), [Advancing TCFD guidance on physical climate risks and opportunities](#).

A policy and business-driven classification of finance end-uses

MDBs adaptation finance by sector grouping

Sector used in MDBs reporting

Cross-cutting issues
Energy, transport and other built environment and infrastructure
Water and wastewater systems
Crop and food production
Other agricultural and ecological resource
Institutional capacity support or technical assistance
Coastal and riverine infrastructure
Industry, manufacturing and trade
Financial services

MDB adaptation finance by sector grouping, 2018 (in US\$ million)



23%	Cross-cutting issues	US\$ 2,964 million
22%	Energy, transport and other built environment and infrastructure	US\$ 2,824 million
18%	Water and wastewater systems	US\$ 2,331 million
17%	Crop and food production	US\$ 2,250 million
13%	Other agricultural and ecological resources	US\$ 1,654 million
5%	Institutional capacity support or technical assistance	US\$ 627 million
1%	Coastal and riverine infrastructure	US\$ 130 million
1%	Industry, manufacturing and trade	US\$ 83 million
1%	Financial services	US\$ 74 million

Climate Policy Initiative's Global Landscape of Climate Finance segments public adaptation financing in similar sectors

Sectors used by CPI's Landscape of Climate Finance

Water and wastewater management	Disaster risk management
Agriculture, forestry, land-use, and natural resource management	Cross-sectoral
Infrastructure, energy, and other built environment	Policy and national budget support & capacity building
Coastal protection	Industry, extractive industries, manufacturing and trade