PROCURING INNOVATIVE CLIMATE CHANGE SERVICES

The PROTECT climate services taxonomy: Applied taxonomy for climate services using Earth Observation

1. Methodology

The aim of the activity was to **create a PROTECT taxonomy fitting** with the five application domains, able to maximize the number of EO-based CS relevant for each domain, later allowing to both service providers and procurers to match their offer/demand with one or more categories of the resulting methodology. The **criteria for fitness-for-purpose** have been defined through an overview of the results and the academic literature for "best practices of CS taxonomies" stemming from EU projects such as MARCO, EU MACS and Climateurope and providing suggestions on what a methodology of CS shall (or shall not) consist of.

The **methodological approach** adopted in the context of T1.2 largely consisted of mapping the PROTECT application domains **against a set of renowned CS methodologies** (and the services considered therein). Benefits and challenges have been identified in the choice and use of taxonomies. Furthermore, major issues have been outlined, resulting from the gaps between supply-driven taxonomies and classification of CS used by end-users, as well as ways procurers deal with these issues. These taxonomies were: the MARCO taxonomy, the Statistical classification of economic activities in the European Community (NACE) taxonomy, The EU Sustainable finance taxonomy, as well as taxonomies not focusing on climate services *per se* – such as the EARSC taxonomy and the EUSPA taxonomy stemming from the 2022 EUSPA Market report.

A general overview of the existing taxonomies is presented below, including advantages and disadvantages, fitness for the purpose, and identified gaps.

"Traditional" CS taxonomies

- The MARCO taxonomy – has its origins in the Horizon Europe project MARCO; its aim was to classify all existing CS.
  The MARCO taxonomy is composed of 30 categories of Climate Services and despite its wide coverage and its broad cover of different stages of the value chains of CS, the taxonomy has been challenging to match with the different applications covered in the PROTECT domains, as the latter focus on a very particular value chain moment (and are limited to EO based services). Similar limitation was also encountered (to a lesser extend) in the case of the NACE taxonomy and the EU Sustainable finance taxonomy.
- The NACE Taxonomy - Initially adopted in the 70s (and updated since) designates the various statistical classifications of economic activities within the EU.
  By design, NACE is broad and, in conclusion of the analyses under T1.2, not specific enough to serve as a base for a taxonomy focused on only five domains of CS, and on a specific data acquisition modalities sought (use of EO).
- The EU Sustainable finance taxonomy - is a classification system, establishing a list of environmentally sustainable economic activities, and is closely related to the idea of

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encouraging activities that help reaching the objectives of, notably, the EU Green Deal. The EU Sustainable finance taxonomy itself is mapped against (and build upon) NACE. While it provides valuable input for structuring the PROTECT taxonomy, and more importantly – showcases an example of a narrower taxonomy based on NACE, the notable difference between the EU Sustainable finance taxonomy and PROTECT, is that the former looks into "environmentally sustainable economic activities" – and not into CS (unlike PROTECT or, for instance, MARCO).

EO taxonomies

The apparent "mismatch" between the PROTECT services on the one hand, and the abovementioned taxonomies on the other hand, brought the need to narrow down the criteria for taxonomies– notably, the specificity of EO, claimed for taxonomies specifically focusing on it (as long as they were including CS).

- The EARSC taxonomy is a taxonomy of domains and types of services where EO has a contribution. While there is not an overarching focus on climate, many of the domains contain services tacking climate change adaptation or mitigation needs, and thus there was a partial match between these few domains and the PROTECT ones.
- The EUSPA Market report taxonomy of EO services seemed to be the one that reflected best the needs of PROTECT (within the five pre-selected domains) as: a) it focuses on sets of operational services available on the market, b) they all include EO (in combination with other sources of data, including in situ and GNSS), c) while few of the domains specifically tackle climate change services, many others also contain instances of EO solutions contributing to adaptation or mitigation.Basing the PROTECT taxonomy on the EUSPA one (not a climate service taxonomy *per se*), ultimately required the additional step of evaluating on a case-by-case basis which of the instances could be considered "Climate Services" as per the 2015 EU definition[1].

The process of mapping the taxonomies can be seen in detail in Annex 1, while the final result- i.e., the PROTECT taxonomy, is showcased below.

2. The PROTECT taxonomy

The outcome of the task – the PROTECT taxonomy, is showcased below.

The taxonomy has the advantage to correspond directly to the needs of the PROTECT project (as this has been the main aim of its elaboration). Thus, combining CS and EO and focusing exclusively on the 5 PROTECT application domains, allowing to reach a particular granularity of the included EO-based CS services.

The list of categories and services included in the PROTECT taxonomy are subject to future adjustments, as other project activities allow to gather feedback from the market (e.g., to include a "new" service, that has not been mapped previously). For instance, this has been the case for "drinking water"

[1] A European research and innovation Roadmap for Climate Services (2015): *For the scope of this document, we attribute to the term a broad meaning, which covers the transformation of climate-related data — together with other relevant information — into customised products such as projections, forecasts, information, trends, economic analysis, assessments (including technology assessment), 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. As such, these services include data, information and knowledge that support adaptation, mitigation and disaster risk management (DRM)*.

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and “water waste management” sub-domain as CS using EO were identified through market consultation and it can be found in the updated taxonomy in the Annex 1.

PROTECT domain	Sub-domain	Category of climate services
Energy and utilities	Renewable energy	Site selection, planning and monitoring for renewable energy
Energy and utilities	Renewable energy	Renewable energy assessment potential and forecast
Energy and utilities	Energy - other	Energy network conditions monitoring
Energy and utilities	Energy - other	Power plant design optimisation
Energy and utilities	Energy - other	Environmental impact assessment of energy and mineral resources plants
Energy and utilities	Energy - other	Pipeline monitoring
Energy and utilities	Waste	Climate data and modelling for waste monitoring and management
Energy and utilities	Drinking water	Climate data and modelling for drinking water monitoring and management
Sustainable urban communities	Environmental monitoring	Air quality monitoring in urban environments
Sustainable urban communities	Environmental monitoring	Thermal auditing
Sustainable urban communities	Environmental monitoring	Urban greening
Sustainable urban communities	Environmental monitoring	Urban heat islands
Sustainable urban communities	Smart cities operations	Smart waste management
Sustainable urban communities	Urban planning and monitoring	Cultural heritage monitoring
Sustainable urban communities	Urban planning and monitoring	Surveying and mapping of urban areas
Sustainable urban communities	Urban planning and monitoring	Urban modelling, 3D modelling, Digital Twins
Sustainable urban communities	Urban planning and monitoring	Urban planning
Sustainable urban communities	Urban mobility	Climate data and modelling for urban mobility monitoring and forecasting
AFOLU	Environmental monitoring	Carbon capture & content assessment

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PROTECT domain	Sub-domain	Category of climate services
AFOLU	Environmental monitoring	Environmental impact monitoring
AFOLU	Environmental monitoring	Deforestation/degradation monitoring
AFOLU	Environmental monitoring	Inland water monitoring
AFOLU	Natural resources monitoring	Biomass monitoring
AFOLU	Natural resources monitoring	Crop yield forecasting
AFOLU	Natural resources monitoring	Soil condition monitoring
AFOLU	Natural resources monitoring	Vegetation monitoring
AFOLU	Natural resources monitoring	Forest Inventory monitoring
AFOLU	Natural resources monitoring	Forest vegetation health monitoring
AFOLU	Operations management	Asset monitoring
AFOLU	Operations management	CAP monitoring
AFOLU	Operations management	Farm management systems
AFOLU	Operations management	Pastureland management
AFOLU	Operations management	Precision irrigation
AFOLU	Operations management	Variable rate application
AFOLU	Weather services for agriculture	Snow and ice
AFOLU	Weather services for agriculture	Climate services for agriculture
AFOLU	Weather services for agriculture	Weather forecasting for agriculture
AFOLU	Operations management	Forest asset management
AFOLU	Operations management	Forest exploitation certification
Marine and coastal environment	Environmental monitoring	Marine pollution monitoring
Marine and coastal environment	Maritime engineering	Marine surveying and mapping
Marine and coastal environment	Maritime engineering	Dredging
Marine and coastal environment	Navigation	Climate data and modelling for navigation
Marine and coastal environment	Ocean services	Meteocean
Marine and coastal environment	Ports	Climate data and modelling for ports
Marine and coastal environment	Vessel tracking	Dark vessel monitoring
Marine and coastal environment	Aquaculture	Climate data and modelling for aquaculture
Marine and coastal environment	Fisheries	Illegal, unreported and unregulated fishing (IUU) control
Marine and coastal environment	Fisheries	Catch optimisation

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PROTECT domain	Sub-domain	Category of climate services
Marine and coastal environment	Fisheries	Fish stock detection
Civil security and protection	Early warning	Forecast
Civil security and protection	Early warning	Monitoring and warning services
Civil security and protection	Migration and settlement	Monitoring and forecasting the climate impact of migration
Civil security and protection	Migration and settlement	Forecasting of climate drivers for migration
Civil security and protection	Post-event analysis	Post-event analysis
Civil security and protection	Preparedness	Preparedness
Civil security and protection	Rapid mapping	Rapid mapping
Civil security and protection	Search and Rescue	Beacons for aviation
Civil security and protection	Search and Rescue	Beacons for land
Civil security and protection	Search and Rescue	Situational awareness supporting search and rescue
Civil security and protection	Infrastructure Planning	Permitting
Civil security and protection	Infrastructure Planning	Vulnerability analysis
Civil security and protection	Insurance for natural disasters	Risk modelling
Civil security and protection	Critical infrastructure	Design of infrastructure
Civil security and protection	Critical infrastructure	Construction operations
Civil security and protection	Critical infrastructure	Monitoring of impact of human activities on infrastructure
Civil security and protection	Critical infrastructure	Infrastructure monitoring
Civil security and protection	Critical infrastructure	Predictive maintenance
Civil security and protection	Critical infrastructure	Emergency assistance
Cross-domain	AFOLU+Civil security and protection	Any relevant climate service
Cross-domain	AFOLU+Energy and utilities	Any relevant climate service
Cross-domain	AFOLU+Marine and coastal environment	Any relevant climate service
Cross-domain	AFOLU+Sustainable urban communities	Any relevant climate service
Cross-domain	Civil security and protection+Energy and utilities	Any relevant climate service

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PROTECT domain	Sub-domain	Category of climate services
Cross-domain	Civil security and protection+Marine and coastal environment	Any relevant climate service
Cross-domain	Civil security and protection+Sustainable urban communities	Any relevant climate service
Cross-domain	Energy and utilities+Marine and coastal environment	Any relevant climate service
Cross-domain	Energy and utilities+Sustainable urban communities	Any relevant climate service
Cross-domain	Marine and coastal environment+Sustainable urban communities	Any relevant climate service

Figure 1. PROTECT taxonomy of EO-based CS

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