Deliverable 4.5

Final report: Modes of representation, synthesis of cases and lessons learned

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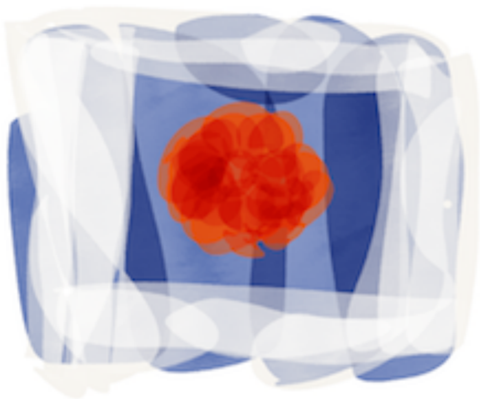

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Summary

Rooted in the main CoCLiServ purpose -community dialogue with climate services in order for them to be more meaningful in a place- the modes of representation are rooted in the 5 CoCliServ sites. From the very beginning of the CoCliServ project to its end in June 2021, the partners saw the progressive stabilization of the 3 main modes of representation: metadata, dynamic mapping, and the Art–science conjoint analysis. The 4-year learning process and the final choices of the modes of representation are the core of this deliverable.

Purpose of the document

The main purposes of the D4.5 document are (i) to put in context and highlight CoCliServ choices for the 3 main modes of representation and (ii) to synthesize the processes related with the modes of representation by site in order to establish what we consider to be the main lessons learned in the context of climate services.

In order to accomplish the purpose of D4.5, we bring together the relevant pieces from the previous milestones and deliverables to summarize the WP 4 and related works. As part of the way to honour the invitation for a book chapter published by Elsevier on "Water and climate change: Sustainable Development, Politics and Social Issues", our chapter is due by October 30th under the title: "Local representations of a changing climate", with a maximum of 8000 words; it will be a distilled version of this final report including: modes of representation, synthesis of cases, and lessons learned.

Relationship to the Description of Work (DOW)

As part of the WP4 "Local representations of a changing climate", this deliverable 4.5 synthesizes the processes and results for Tasks 4.2 (metadata), 4.3 (dynamic mapping) and 4.4 (Art–science conjoint analysis). Task 4.1, related to science mediation formats, does not need to be summarized and is presented in D4.1. The citizen sciences component has become progressively integrated into WP5, where the results are presented.

Context and highlight of the 3 modes of representation

The representation modes contain the challenges related to their roles in supporting WPs 1-3 and their representation needs. What are the modes of representation for narratives (WP1)? What are they for scenarios (WP2)? What are they for local climate information in context (WP3)? Each of the previous WWPP addressed these questions as they did the previous tasks from this work package: from the point of view of the metadata, the dynamic-mapping, and the Art-science conjoint analysis. The common challenges are historically rooted in social representation (Moscovici, 1961), articulating individual thinking and feeling with collective interaction and communication: “Social representations [...] concern the contents of everyday thinking and the stock of ideas that give coherence to our religious beliefs, political ideas and the connections we create as spontaneously as we breathe” (Moscovici, 1988) and the complementary approaches developed since then (e.g. Latour 2011; Jacobson et al. 2016; Burke et al. 2018; Armstrong and Leimbach 2019) with the intention to address “ everyday thinking”. From the approaches, experiences and associated knowledges accumulated during WP1, 2 and 3, we reached the edges and challenges from the three WP4 pillars: metadata, dynamic-mapping, and the Art-science conjoint analysis.

Metadata context and highlights

Metadata[1] appear early in CoCliServ as one of the ways to improving the "data about data" related questions. Appeared in the nineties with the plan to describe and manage internet resources, but metadata existed and had been in use for a long time before the word was invented. Wherever numerous objects of a same kind need to be discriminated, metadata are handy. The term may be essentially understood as a synonym of "description". Any field of study requiring classification and cataloguing of objects or ideas secretes its own system of metadata. Typical examples of metadata generators and consumers are archives: every library relies on some metadata scheme that makes the search for a document possible within a catalogue raisonné where books are listed and briefly described, usually in some coded fashion. Consulting a catalogue implies the prior knowledge of its underlying convention – that is, of the metadata scheme. Hence the interest of defining metadata schemes that are common to the collectivity of actors and users of a given domain, which then become standards. A worldwide example is the International Standard Bibliographic Description (ISBD) for written documents, produced by the International Federation of Library Associations and Institutions (IFLA). The advent of digital information has brought an additional dimension to metadata to the extent that they can be – and very often are – automatically produced and read, and are usually made searchable via online

[1] *Metadata is a hybrid derivation of the Latin data and the Greek meta ("along with; besides, over and above; beyond"), a prefix often used, in modern languages, to pointto some self-reference (as in metalanguage). A consistent neologism would be circadata (from the Latin) or metadedomena (from the Greek), although dedomena issometimes reserved by philosophers to denote "phenomena that exist prior to interpretation" (Luciano Floridi), likely because in modern languagesdata encompasses observations and measurements, which can be viewed as a basic form of interpretation.*

interactive catalogues. Institutions and professional activities that generate data and for which sharing information is crucial are confronted to a similar issue. In Earth Observation sciences, for example, the production of huge amounts of satellite and model data has made the standardisation of metadata indispensable.

One of the main challenges is to investigate the possibility and pertinence of defining a metadata scheme for a set of narratives and scenarios for use in the CoCliServ project. After providing an overview of what is understood by "data" and by "metadata", and of what metadata are used for.

The first proposed metadata scheme is based on discussions held during the CoCliServ kick-off meeting (Île d'Arz, 9-13 October 2017) and is intended to support the consortium's informed decision about the pertinence of adopting or rejecting the principle of using a metadata scheme in this context.

Data and more

Metadata imply the existence of data. Data is the plural of the Latin datum ("given"). In English, the Oxford dictionary proposes "a piece of information", and Dictionary.com adds… "an item of data" (sic). Data are thus not necessarily numbers, but can be any elements carrying information. Viewed through a library catalogue, books are data, even if one may argue that one single book is usually meant to carry many pieces of information – and sometimes carries no information at all. The Oxford dictionary extends its first definition to something that is close to hypothesis: "an assumption or premise from which inferences may be drawn". In the wake of the Oxford dictionary, Dictionary.com adds that, in philosophy, datum means "any fact assumed to be a matter of direct observation; any proposition assumed or given, from which conclusions may be drawn". In this respect, narratives can certainly be considered as data. As for Merriam-Webster, it lists the following synonyms of datum: fact, detail, nicety, particular, particularity, point, specific.

Granularity

Most of the time, metadata refer to data sets, which prompts the question of what demarcates a data set (or dataset). The answer will be a matter of context and the nature of the criteria used to delimit a dataset will vary. For example, in Earth observation (EO) sciences, a dataset may be defined as the set of data collected at a common site or from a common platform, included in a common file or in some defined series of files, etc.

One metadata set may refer to a datum, to a dataset, to a series of datasets…

Beyond data

… and, as some of the above examples show, metadata may relate to objects (books, internet resources) that can hardly be considered as data stricto sensu. One of the first metadata fields in a metadata scheme is often the category of objects to which the metadata set applies, which may be different from a datum or a dataset. In INSPIRE, for example, it can be a dataset, a dataset series or a service. While the first two things have clearly something to do with data, the latter is connected to data only to the extent that it deals with data.

What are metadata?

As mentioned in the introduction, metadata are elements of description of a defined category of objects – considered as data in a very general sense. These descriptive elements are usually structured (they are divided in categories or chapters, they relate to each other, they obey certain rules). The generic elements and their organisation form a conceptual metadata model, or scheme, or system – in this context, the terms are synonyms. Since the scheme reflects common properties of the objects it encompasses, the broader the variety of the data, the more laconic the metadata scheme.

In a context where the passing and traceability of information are key – which will be the case every time the data collectors and users are different people –, the raison d'être of metadata is to support the use of the data. This is not always as obvious as it sounds: dangers exist of developing metadata for the sake of fashion or to comply with some pre-existing information structure (e.g. one relying on automated reading), possibly favouring formal aspects at the expense of the information content.

Functional types

In any case, their function (i.e. supporting data use) explains the distinction often made between various types of metadata, depending on which stage of data usage they relate to. Many metadata schemes include three basic subsets:

i. elements informing on the existence, location and availability of the data, making the search for – and, but not mandatory, the access to – the data possible ("discovery" metadata), usually through some catalogue – e.g. index, author's or provider's name (usually an institution or organisation rather than a person), date of issue, type of object, brief description, URL, conditions of access and use, …;

ii. elements describing the data formal display, providing guidance on how to read the data once acquired or accessed – e.g. language, data format, number of columns in a data file and which datum is recorded in which column, …;

iii. elements pertaining to the data nature, allowing their understanding and informed use – e.g. conditions of data collection; physical processes involved; successive stages of the data processing chain; algorithm characteristics; nature, unit and uncertainty of a physical quantity; "fill" value used to signal missing or suspicious data; warnings and limitations to take into account in applications; paper references; …

Any of these types may be split up into finer categories if so wished. It should also be noted that the three types identified above actually overlap, so that frontiers between them are somewhat fuzzy.

Some data may be inaccessible – e.g. because they are recognised confidential by law or by individuals – or accessible only to authorised users or after payment of some fee, and still be described by public metadata. It is likely to be the case of CoCliServ narratives because of their private nature, and likely not of scenarios, which will have lost the narratives' personal stamp and should allow WP3 to derive from them the needs in climate information.

When data are of restricted access, part of the metadata may be used to supply the minimal information allowing some simple data analysis (e.g. classification, statistics). This can also be true when data are accessible, in which case the preliminary analysis based on the metadata can be refined by more in-depth data study at a later stage.

Metadata field common properties

Each metadata field of some metadata scheme will be given zero, one or more values when applied to an actual dataset or object. It is like an empty box ready to be filled in, and this is actually how it will appear in a questionnaire aimed at collecting metadata.

Each metadata field has a name (in some schemes, it has also an identification code number). Common metadata fields, for example, are Resource title and Resource abstract, or something equivalent.

In the above examples, the field values are left to the metadata supplier's imagination but sometimes a field value must be selected among a list of predefined values. For example, the INSPIRE Type of resource must be given one of the three values data set, data set series, service – for the SUVIM Observations, it will be data set.

The multiplicity of a metadata field is the number of values it may accept, namely one of the following.

1 (one)

1 (one) or several 0 (zero) or 1 (one)

0 (zero), 1 (one) or several

If the multiplicity of a field is strictly higher than zero (first two cases above), the field is said to be mandatory – that is, the metadata supplier is expected to provide at least one value for this field. The above three examples (resource title, abstract and type) are all of multiplicity 1 in INSPIRE: each resource must have one and only one title, one and only one abstract, one and only one type. A field may have a multiplicity equal to any undefined integer higher than one. For example, the field Keyword may accept any finite number of values in INSPIRE, but must be given at least one. The INSPIRE Spatial data service type, for example, will have no value when the resource is a data set, and will have one value when the resource is a service.

One could imagine metadata schemes where the multiplicity of some fields is limited to a specified number, for example where there could be no more than five keyword values.

Finally, the multiplicity of a field may depend on some condition. It is actually the case of the last example quoted above: in INSPIRE, the multiplicity of the spatial data service type will be 1 if the resource is a service and 0 otherwise.

Some condition may also apply to other field features. For example, some field may only accept an integer number as a value, or a piece of text ("string"), or a date in the format dd/mm/yyyy, or a distance expressed in km, etc. Sometimes, a field value must comply with some existing standard, be picked in some imposed thesaurus (e.g. of geographical toponymy) or be expressed in conformance with some imposed frame of reference (for example, the Gregorian calendar for a date).

Sometimes, the standard, thesaurus or frame of reference may be chosen by the data supplier, in which case it must be stated in the metadata. In order to record such kind of information, some metadata schemes offer the possibility to complement metadata field values by attributes.

Metametadata

Some fields in a metadata scheme may relate not to the data but to the metadata. For example, the metadata language, the date when the metadata were created, their originator, etc.

Quality

The provision of metadata only contributes to support data use at the condition that they meet certain quality criteria. "Good" metadata will be

- specific (addressing the level of detail required to an in-depth understanding);
- accurate (not leaving dark or fuzzy areas, ambiguities or room for misunderstanding);
- intelligible (formulated in a logically and grammatically correct language);

• explicit (avoiding coded information, abbreviations and undocumented conventions, and providing references where needed);

• complete (exhaustive enough to allow data discovery, assessment of fitness for purpose and proper use);

• consistent (organised and classified according to some sensible scheme, which will ease the metadata search).

Pitfalls

A very common flaw of models, forms and questionnaires is that they do not expect the unexpected, with the consequence that some cases are either excluded or forced to assume a coat that is too skimpy and betrays its bearer. When defining a metadata scheme, it is therefore advisable

• to get, as far as possible, a complete idea of the objects targeted in order to provide an adequate metadata frame;

• to include 0 in the field multiplicities (which somehow corresponds to the "unknown / not applicable" answer); this will provide more freedom to the metadata supplier, with the drawback that a metadata set where most fields are void is not very informative (some balance must be achieved);

• to include the "other" option in predefined lists and drop down menus and to provide the possibility of entering free text.

Whenever some procedure is standardised, there is a subtle balance to be achieved. The prospective of automation sometimes introduces a bias in favour of the latter. In INSPIRE, for example, at least one date (called temporal reference) must be provided for every resource. But it can be anything among a collection start or end date, a date of creation, of publication, of revision, which oddly decreases the informative content of the field.

Another pitfall is that some metadata fields will depend on personal judgements. The question of which properties of a dataset will be retained to appear in the resource abstract, for example, is a matter of individual appraisal and may depend on factors such as one known current application or more personal preferences. The impact of subjectivity may be considered minor when describing UV index data is at stake. For narratives, not only the choice of the fields forming the metadata scheme, but also the values that these fields will assume will strongly depend on personal assessments. For example, if a narrative is not explicitly envisioning the future but, according to some, allows to derive dreams of the future, will it be labelled as containing information for future scenarios? If a narrative does not explicitly mention the need in climate information but could, according to some, be directly or indirectly related to climate issues, will it be labelled as climate-connected? The impact of subjectivity on the metadata content is not a flaw, but it can be a trap if it is not acknowledged explicitly, for example by some warning.

Quotation

A side effect of complying with a widely recognised metadata standard is to increase the visibility, and hence the use, of the described datasets by integrating their metadata to the associated network. Complying with the INSPIRE metadata, for example, will allow the dataset to be documented through the online INSPIRE Geoportal. Compliance with the CF Metadata Conventions will ensure the swift integration of a climate dataset to comparison exercises or statistical analyses.

In some cases, visibility is not barely a side effect but the declared objective. The DOI metadata scheme was set up to allow a variety of objects, including datasets, to be quoted in publications in a similar way as papers are (and more).

Examples

The following three examples belong to a range of metadata schemes developed in rather different contexts. They illustrate how the metadata systems serve their purpose of supporting data usage. The examples below could all be of interest for CoCliServ in some respect, if only to help figuring out what metadata may look like. The first one is widely used in climate physics and could hence be encountered when fetching climate data. The other two pertain to much broader domains; some of their features could be borrowed to build up an original narrative and/or scenario metadata scheme. If judged helpful, one could perhaps even consider to develop a narrative/scenario metadata scheme complying with the last of them.

Example 1: The Climate and Forecast (CF) Conventions

In physical sciences, a large part of the research consists in the analysis of data that translate observation or calculation results in some coded way, often (but not always) numerical – and, today, generally in electronic format. The data sets most commonly encountered in Earth physics are records of numerical values of some physical quantity, usually derived from direct measurements of some other physical quantity through an algorithm and, in the best case, provided with an evaluation of the associated uncertainty; the data may also be the outcome of some numerical encryption of non-numerical observations; they may stem from speculative attempts to reproduce or forecast the evolution of some aspect of the physical world using computer models.

In any case, in order to infer meaningful information from the data, the analyst must not only know the code underlying the translation, but also the data format and ancillary information of various nature, such as the data unit, observational conditions or computing hypotheses and approximations, references of papers describing the retrieval algorithm, version number and changes with regard to the previous version, who to contact, and, last but not least, a documented assessment of the uncertainty (or uncertainties) affecting the data. Even when the observer (or the data collector, retriever or modeller) and the analyst are the same person, which is less and less commonly true, this knowledge must be stated explicitly to enable other persons to perform possible future re-analysis. Metadata ensure that this knowledge is shared and passed on seamlessly to anyone willing to use or re-use the data.

The Climate and Forecast (CF) Conventions were developed to fulfil this purpose for Earth observation and modelling data. Initially designed for data filed in NetCDF format and intended to be stored in the same file as the data (in the "file header"), the CF metadata are actually independent of any particular digital format and can document the values assumed by any function of independent coordinates at discrete points of its domain of definition. In Earth physics, the independent coordinates are usually (but not always) one or several of the four "dimensions" longitude, latitude, height or depth, and time. The considered function is called "variable" – and sometimes "dependent variable" to distinguish it from the coordinates (the "independent variables"). The CF conventions are general enough to describe any discrete function (not only geophysical variables), that is, any array of zero, one or several dimensions (a 0dimensional array is a scalar, i.e. a variable having only one value). For example, one independent coordinate may be a temperature, or the solar zenith angle, or a station name, or the name of a butterfly, or an index standing for any item on which the variable depends. One often speaks of "gridded data" since the domain of definition of the variable can be represented by a discrete set of points in a multi-dimensional reference frame where each axis represents one coordinate.

The CF Conventions only require that the basic information be given about independent and dependent variables. It is up to each community of data producers and users to define which set of metadata they want to be systematically included in the data file headers.

The metadata are divided into "global attributes" pertaining to the dataset as a whole (e.g. title, institution, history, ...) and information about coordinates, variables and their specific attributes, like unit, valid range, filling value (to signal gaps in the data), standard error, reference frame, etc. A variable has a standard name. It may also be given a "long name" made up by the (meta)data provider according to certain rules.

The CF Conventions include a table of geophysical variable standard names. Prompted by the need to name some variable not yet in the list, anyone may submit a request to the CF committee to expand the table of standard names. Each request is subject to an online discussion chaired by a moderator, to which anybody may take part. The whole procedure and the conditions at which the proposed addition or change to the table is accepted are detailed in the online CF governance document.

Example 2: INSPIRE

The European Directive establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) [R6] was published in the Official Journal of the European Union on the 25th of April 2007. It entered into force twenty days later. By the 15th of May 2009, Member States had to design and implement some administrative and legislative corpus to comply with its clauses.

The Directive scope includes any dataset with a social usefulness, detained in a Member State of the European Union (EU), in electronic format, which possesses a geographic extent or is related to some geographic location – which is the way "spatial" must be understood in this context. The double objective of the Directive is to harmonise such datasets over the European continent and to make them freely available to the community (citizens, administrations, agencies, universities, research institutions, hospitals, doctors, policy makers, etc.) all over Europe, through a network of distributed information facilities and services. The EU member states have the obligation to document and provide all the data sets falling in the scope of INSPIRE, as long as they do not contain any piece of information protected by confidentiality obligations. The datasets that have been made available in this way so far are documented on the INSPIRE online geoportal [W4]. Each dataset reported must be associated to at least one discovery service, one view service, one download service and one transformation service and all these services must be INSPIRE-compliant and documented on the INSPIRE Geoportal.

The thirty-four "data themes" targeted by INSPIRE are listed in three annexes to the Directive. They encompass subject matters as diverse in nature as postal addresses, transport networks, epidemiology, atmospheric and meteorological conditions, oceanographic geographic features, … Although many themes could be relevant for CoCliServ (e.g. hydrography, protected sites, land use, human health and safety, agricultural and aquaculture facilities, demography, natural risk zones, habitats and biotopes, …), narratives and scenarios do not fit into any of the categories listed. There is therefore no point in trying to comply with the INSPIRE rules with the aim of integrating CoCliServ narratives or scenarios to the INSPIRE network. But some elements of the INSPIRE metadata could be retained and be integrated to a metadata scheme adapted to narratives and scenarios.

The INSPIRE Metadata Regulation [R4] defines the minimal discovery metadata required for a dataset to be integrated to the INSPIRE data network. Given the variety of the subject matters tackled by INSPIRE, this scheme is very general: it only includes metadata fields that can apply to almost any type of information with a geographic facet, plus elements of information referring directly to the Directive. Metadata fields specific to every data theme are proposed in the nonbinding INSPIRE thematic Data Specification Technical Guidelines. There is one such document per data theme.

Example 3: DOI

Strictly speaking, the Digital Object Identifier (DOI) is one particular Uniform Resource Identifier (URI). It is composed of a prefix and a suffix separated by a "slash" sign. It can be allocated to an object in order to identify this object in a univocal fashion. In the expression "Digital Object Identifier", it is the identifier which is digital, not the object – at least, not necessarily. However, as will be seen below, a uniform resource locator (URL) will be automatically allocated to the object at the same time as the DOI; this URL will point to a factsheet about the object. Once allocated to an object, the DOI is permanent (it cannot be deleted). If an object has successive versions, the DOI refers to a defined version; another DOI must be requested for each new version.

Initially, the DOI was set up by analogy to the International Standard Book Number (ISBN), in order to allow citation of – and electronic linkage to information about – documents, media, articles and datasets, but it is in the process of being generalised to other categories of objects.

DOIs are allocated on demand by DOI Registration Agencies. IASB is accredited as a DOI Registration Agency (RA) and can serve as a DOI provider for CoCliServ if required.

A metadata scheme is part of the DOI system. A technical description of it is provided in Chapter 4 of the DOI Handbook. The DOI metadata system is very open and flexible, and requirements are minimal. Very few pieces of information are mandatory but a number of them are recommended by the International DOI Foundation (IDF).

A kernel of metadata must be supplied on application, but even the nature and number of the metadata fields belonging to this kernel are left to the diverse RAs' appreciation. Many RAs have an online application form using an interface developed by DataCite, that allows numerous fields to have a multiplicity higher than one.

When applying for a DOI via IASB-BIRA, applicants must submit a minimal set of metadata. The online form also allows them to supply optional additional metadata. If they wish, they can also upload a PDF factsheet where they write anything they find useful to describe the referred object (e.g. introduction, project description, campaign location and time period, data description, object (in)accessibility, conditions of use, contact details of data manager and responsible person, paper references, possible applications, URL linking to data information or distribution website, …). The object will be allocated a DOI formed of a prefix and a suffix separated by a "slash" sign (/). A URL pointing to the metadata set and the factsheet stored on a secured server at IASB will be univocally associated to the object.

CoCliServ metadata choices

Starting from a basic skeleton, the CoCliServ narrative metadata scheme was further developed and took shape progressively, as discussions went on with the site and work package leaders. The final result (which would probably have evolved further, would the project have continued) is presented at the end of the current document.

The following sections account for different aspects of it that we had to examine in the course of the work. Along the way, they highlight some challenges we had to face and choices we had to make.

One of the first questions that arose was the type of objects that had to be described and categorised to serve the project objectives while exploring innovative ways forward. As the project elementary building blocks, narratives or sets of narratives were the most obvious candidates, but the possibility to create metadata for other types or sets of objects studied by CoCliServ was also envisaged. Such objects included scenarios (derived from the narratives) and chronotopes (understood as physical or conceptual space-time milestones). It was even proposed to develop metadata for managerial objects such as deliverables or project milestones. However, creating metadata for narratives revealed ample and challenging enough to monopolise the human resources in presence, and efforts exclusively focused on this task.

Granularity

The initial metadata scheme proposed in the *Available modes of representation* document considered three levels of metadata, corresponding to three levels of aggregation:

level 3 – metadata characterising any narrative;

level 2 – metadata characterising the set of narratives from one of the five project sites;

level 1 – metadata characterising the entire set of narratives collected by the project.

It soon appeared that in the context of a single project, only the level 3 metadata offered any interest so we focused on the development of a metadata scheme where the described objects were the individual narratives.

In the metadata context narratives were conceived as the original tales collected by the site leading teams: one narrative would be a story told, written, painted, illustrated, discovered by one individual or collectivity, who could be anonymous but would generally have a definite identity. Metadata were developed with this relatively non-constraining definition of a narrative in mind.

Toward the end of the project, one of the partners underlined the fact that what she called narratives were synthetic stories derived from a set of similar individual testimonials, retaining their common prominent features. In other words, narratives were not the individual pieces of raw material collected, but already resulted from some processing of this material, highlighting recurrent typical concerns through some disembodied or fictive story. It made more sense, for her work, to characterise such narratives than to describe in detail every singular story.

The point she raised was actually a matter of granularity, since the synthetic narratives she had in mind aggregated, somehow, sets of similar individual narratives. A large number of metadata fields required to characterise singular narratives, especially among the pieces of *contextual information* listed in the annex (such as the identity of the narrative's author or the place and circumstances where and when the narrative was collected), would not be relevant for synthetic narratives any longer.

There was no time left to change course, so pursued up to that point. But it would be worth, for future projects similar to CoCliServ integrating a metadata application, to devote some time, at the beginning, to questioning which levels of granularity are desirable or useful for the work undertaken. In contexts where traceability (and hence posterity) is key, documenting individual pieces of raw material sounds like an appropriate decision. Where the focus is to highlight prominent features arising from some stage of the analysis, characterising datasets or abstractions derived from particular observations may be preferred.

That said, as will be examined more closely in the provided the personal aspect of most narratives to be collected, it was decided at the start that their contents would not be divulged, not even to the project co-partners, apart from quotes representative of climate-related local concerns. One may observe that metadata of singular objects may serve to filter or group these objects according to the criteria that are relevant for the defined research; that is, they may help to construct emblematic abstractions like synthetic narratives.

Confidentiality

Provided the personal aspect of most narratives to be collected, it was decided at the start that their contents would not be divulged, not even to the project co-partners, apart from quotes representative of climate-related local concerns.

At the beginning, the intention to represent the narratives using metadata was met with reluctance by some partners, who feared that this approach would violate the confidentiality of information entrusted to them. They were however reassured by the possibility to tag selected metadata fields with a "confidential" stamp that would prevent them from being seen by internal or external users of the metadatabase: personal details about the authors, stored in the metadata, would be kept unveiled, as well as any information likely to reveal their identity. As will be seen in the second part of this document, the mapping tool developed at ULB offered easy technical solutions to achieve confidentiality, such as fuzzy geo-referencing.

Functionality

Beside the interest that may – or may not – lye in enunciating and naming for their own sake, metadata may serve a number of purposes.

In climate science, for example, where data are the numeric results of physical measurements, it has become traditional to distinguish between *discovery*, format and intrinsic metadata. Discovery metadata encompass elements informing on the existence, location and availability of the data, making the search for – and, but not mandatorily, the access to – the data possible, usually through a catalogue. Format metadata, especially relevant when data are stored in electronic files, inform on the data formal display, providing guidance on how to read the data once downloaded. Intrinsic metadata pertain to the data nature, allowing their understanding and informed use. One of the key pieces of information stored as intrinsic metadata is the data uncertainty, i.e. an assessment of their *closeness to truth*.

Although inspired from natural science practice and from libraries, CoCliServ metadata do not have a similar vocation, since the data collected by its partners are not, as such, intended for public dissemination. Yet, to the extent that they provide a common wording framework and support the data analysis, they can be far more than a gimmick for attractive representations.

Traceability

Metadata are a convenient instrument to keep, in a concise homogeneous form, the memory of the work accomplished, of the methods applied and of the original elements (here, the narratives) that led to the project conclusions. When used in a systematic way throughout a project, they can provide accurate information to later researchers interested in the subject, while avoiding diving into the bits and bobs of the actual stories, which are confidential anyway.

Visualisation and dissemination

By standardising the description of narratives with words and by providing the underlying information to the geographic mapping tool developed by Task 4.3, narrative metadata contributed to WP4 (Representations) and had a potential to support, through visual representations, the dissemination of the project outcome ensured by WP6 (Coordination and dissemination).

Comparing, sorting, aggregating

Metadata are an instrument to standardise the way an object is described. In retaining some features and excluding other ones, they somehow disarticulate the objects under study. When these objects are stories enunciated by humans, anthropologists may rightfully dislike the method, since it reduces vivid accounts to formal lists of factual elements and discards any unforeseen consideration – that would possibly throw some original light on the question tackled. The critic is justified. Yet, when it comes to forge a general image of the various views or wishes of people belonging to a certain community, or to establish statistics, metadata offer an appropriate medium to compare narratives to each other based on common criteria, sort them out in categories and aggregate them into archetypical narratives, as already mentioned.

Data analysis

When the work on metadata started, it was debated whether they should be used for other purposes than recording basic facts about the narratives. However, their potential to support the analysis performed in the various work packages became clear as the project proceeded. The scheme was progressively extended to include metadata fields informing the researchers on features relating to their part of the study. At the work package leaders' demand, the *analytical information* (see Annex), which at first only included an abstract, keywords, names of places mentioned by the narrator and quotes, was successively completed by the following metadata fields to support WP1 (Narratives of change), WP2 (Scenario design and development), WP3 (Local climate information in context) and WP5 (Knowledge quality assessment). In the end, this enlarged functionality of the metadata was not exploited, but it was recognized by the partners as a potentially useful analysis tool.

Narratives of change

Metadata value: *Yes / No*.

Mention of the future	desired future
	feared future
	without hope or fear overtone
Mention of climate	past climate
	present climate
	possible future climate impacts

Scenario design and development

Metadata value: tick / no tick.

Potential for a hinge point	unclear	
	no	
	yes	climate-related
		not climate-related
		relationship to climate undecidable
		can be controlled
		cannot be controlled
		control possibility unclear

Local climate information in context

Metadata value: tick / no tick.

Mention of meteorological physical parameter	air temperature
	sea surface temperature
	soil temperature
	air humidity

	cloudiness	
	precipitation (rainfall, snow, hail)	
	wind (speed and/or direction)	
Mention of climate-related phenomenon, event or landscape feature	storm(s)	
	drought(s)	
	natural fire(s)	
	flood(s)	
	freshwater, river system	
	sea level	
	coast line	
	salinity	
	other	please state
Mention of life aspect in relation to climate	air quality	
	water supply	
	agriculture	
	food supply	
	energy supply	
	ecology	
	vegetation, forestry	
	animal life	
	health	
	economy	
	education	
	culture	
	human population density	
	human migration	
	peace	
	politics	
	other	please state

Knowledge quality assessment

Metadata value: free text.

Knowledge types on which analysis and/or prediction of the site future is based	type 1	knowledge type
		reasons for trust
		identified uncertainties
	type 2	knowledge type
		reasons for trust
		identified uncertainties

	type 3	knowledge type
		reasons for trust
		identified uncertainties
Knowledge quality aspects	mentioned knowledge quality criteria	
	mentioned knowledge issues	

Dynamic mapping context and highlights

At the very beginning of the project a database has been created and spatially enabled to centralise the data collected during the whole life of CoCliServ and possibly beyond. It is currently hosted on a PostgreSQL server based in the ULB and can be reached from anywhere with suitable tools like QGis, LibreOffice, PgAdmin, and many others open-source or proprietary, depending on the purpose and usage expected (with or without spatial dimensions, as regular user vs manager, …). Currently we will start with QGis as we focus on the spatial aspects. QGis is available freely from here: www.qgis.org.

In the early stages the database contains very symbolic data, such as the study sites delimitations, general purpose glossaries for the narratives metadata, and a table designed to store the narratives and their metadata.

The narratives themselves can be stored as raw text or url's linking to documents stored on a web server such as images or pdfs (for instance a scan of a newspaper article stored as an image). The constituents of the narratives still need to be listed and described by the WP1 team.

The narratives can be positioned on a map, either during their recording or afterwards; they are recorded along with metadata as described in the metadata section. This should help studying or classifying the narratives afterwards by type, content, time, location, … and hence relate them with other contextual information.

To enter a narrative into the database, the current proposition is to use QGis and the forms we have prepared. Later we hope to propose other tools to interface with the database but QGis is pretty versatile and (relatively) easy to use.

When creating a narrative with QGis a form opens, the information entered in this form will automatically be stored and some metadata will be generated (who did it, when, which site, ...) in the database, upon saving the modification. A symbol will then appear on the map and the narrative will be available for any authorized user.

Users need to be identified and privileges can be fine-tuned to respect the information restriction.

Aggregated (or not) information could also be displayed on web interface for follow up purpose.

The objectives are to keep track of what has been done, to standardize somehow the data collection, to integrate this task with the other ones and to stimulate the interactions between us. You are invited to express your needs and / or remarks regarding the development of this tool. We will create user accounts for those interested and explain how to use the tool (at least for testing purpose).

CoCliServ dynamic mapping choices

Dynamic mapping initially described as : "develop a spatial database, in relation with regular databases, to support WP1-2-3 activities with mapping: spatial representation of global trends for use in WP1-2-3; interactive dynamic visualization support tool for WP1-2-3, sharing WP1-2-3 output between case studies (if needed) and WPs, graphical interface for visualizing spatial objects and for database interactions, provide and centralize material for mapping purposes" brings to the resulting work is a tool made to be used by regular users in a research context, allowing, thanks to the metadata standardization achieved in Task 4.2, to share (anonymous) data between study sites, between work packages or with other analogous projects.

The development of the database

So the central element of our system is a database. The concept of "database" ranges from any set of data, like an address book or an MS Excel file for example, to a computer highly mathematical structure like the well-known Oracle, MS SQL or MySQL, which are (Relational) Data Base Management Systems (RDBMS). Because they are very efficient tools these systems are now everywhere on all computers or smartphones, in all softwares and most web pages rely on them. They ensure a great safety for the data, they are very resistant to data corruption, they control very efficiently the accesses and allow to define specific privileges to the different users.

As said earlier this is the kind of tool we are using and we have chosen PostgreSQL which is also the choice of many important businesses and administrations around the world (like Google Earth, the French and Swiss statistical national institutes). PostgreSQL itself can manage regular data (numbers, text, dates, ...) and it has an extension named PostGis that gives it the ability to manage geographical or geometric data (points, lines, polygons). PostgreSQL complies with open standards, is open source itself (meaning it does not depend on private technologies), uses the SQL language. A database developed inside PostgreSQL can therefore be managed by anyone having access to it and having the skills for it. The schema itself (the database structure and all the functions added) can be exported as a pure text file and installed on any other PostgreSQL host, or transformed in another RDBMS format. The data can be exported as well together with the schema or in a single compressed file (a "dump") or in individual tabular files (like "csv").

So we created a database containing tables and functions. The general structure of the tables is based on the work made in the metadata part of CoCliServ; they are of course a little adapted to comply with the SQL logic and with the interface tool we made with QGis. The database structure remains simple. The functions were added to ease the work of the user, either by adding some information like the name of the user, the date of the recording, the study site based on the location, re-organise the stage numbers inside a recorded journey (see below), etc, or to do some post-processing, like inserting new values to drop-down lists. Without these code elements, data recording would be more complicated and more error-prone.

QGis

As presented above, QGis is a free and open-source software, quite easy to use and very rich in functionalities. It can be used to create regular maps but offers also lots of analytical functionalities, automation of processes, a programming environment in Python. It can use many different types of data and of course it can connect to database servers like PostgreSQL/PostGis.

So the data are either stored in files or in connected servers and are all organized in layers put one above the others, like in an image editor. The data in the main window are overlapping the ones from the layers below.

Among its user-friendly tools there is the ability to create forms connected to a data layer, so that by clicking on a feature belonging to a layer a window will open and display the specific attributes of that feature in a way pre-defined in the layer properties. This is the functionality we use in our tools, knowing that the form can contain many tabs, containing themselves several blocks, that can be hidden or displayed according to the value of other attributes. So the form will evolve along with the filling of the attributes by the user, hiding blocks of attributes that would not be relevant anymore and showing the ones that could for instance be useful to add some more relevant information. For example, imagine that the user is recording information about a book, then the block of data containing everything needed to describe a book would appear (title, author, publication date, content description, etc) while the blocks containing the attributes useful for describing a migration journey would be hidden. The form is versatile.

In QGis all the data are organized in a 'project' which is where all the information regarding the list of layers, the formatting (the symbols, the colors, the forms, etc) are stored. The layers (the 'real' data) are stored elsewhere, in files or in web servers. Since we are working with a dedicated server the data and the project itself are also stored on the server (except the base maps which are provided by public servers like OSM or Google), so that the user can change of computer without having to carry everything with him/her, all he/she needs is to remember his/her credentials.

QGis/PostGis interconnection

As is often the case in IT, the tasks are shared between front-end and back-end. Qgis offers the front-end, i.e. the system with which the user interacts and which contains a minimum of the logic, while PostGis ensures the real data management. In this way, we could, if necessary and with minimal workload, replace or supplement QGis with another system, such as a smartphone or tablet application, and continue to work with the same database. We could also connect analytical tools, such as statistical software, to PostGis and perform analysis or mix data with other sources. Access is concurrent, which means that different users can work at the same time doing similar or different things. Still for now we use QGis because it fits the project requirements which were above all cartographic.

So the work would go like this:

- The user opens QGis and the CoCliserv project, which opens the connection to the server, which then identifies the user,
- The user chooses a task by selecting it in a list within a little window, like recording a new case (whatever it is) or updating one or adding information.
- If the task is recording a new case the user starts by clicking somewhere on the map, supposedly on a place in relation with the case, otherwise the user clicks on the case to modify, then a form predefined for the kind of task opens.
- At the end the user saves its work by clicking on 'save' then the database processes the data which are then organized according to the database structure. Possibly some symbol appears or changes on the map, on the user' screen and on any other user's.

A QGis project is personal to each user. The users are free to modify it, like replace symbols with others, change the colors, even the dialog in the forms, as long as he/she knows what he/she is doing. Having the projects stored on the server allows the system manager to create a new project whenever a new user joins, or alter existing projects whenever new functionalities are added or issues are fixed.

The users

We have mentioned above the 'users' but we need to clarify who they are and what they are allowed or invited to do. There are fundamentally three kinds of users:

- The regular users who are simply using QGis and the CoCliServ tools, and who only need to understand the basic use of QGis and who can only use the system 'as is'.
- 'Power users' with the rights to modify the system parameters,
- The system manager, who fixes the tools and who is above all in charge of the server, and therefore must have a good technical background with spatial databases and GIS.

Of course, daily work can be done by regular users without any assistance, possibly there may be a need for power users and the system manager is only required for developing the tools or adding new functionalities.

The 'Power users' can change the system parameters because they are allowed to add/modify content inside specific tables. For instance, there is a table containing the different languages the data can refer to, or a table with allowed keywords, another one with media that can be used for recording purpose, etc, and the need might appear to add one item in one of those tables, in order to make it available for use.

One of the features that was requested and that we included in the tool was the ability to extend easily a predefined list of categories: the interface of the tool offers fields to be filled, and some offer the possibility to make a selection between different values, but it can happen that the correct answer is not included in the list and therefore we have added the ability for the regular user to add new values that will immediately be added to the default list for the other users as well. The advantage is that these predefined lists are progressively elaborated by the users themselves but the drawback is that it could lead to duplicates or the to the inclusion of not relevant answers. This feature should therefore be evaluated carefully before enabling it or not.

The data

As said above, a list of attributes was elaborated in the metadata part of this work package, and the database reflects accurately this list but the general organization of the information is adapted to comply with the relational model and the QGis interface requirements.

First of all, the reader might be confused by the use of the words 'data' and 'metadata'. The metadata are nothing else but data about data, meaning usually that they define a set of data by specifying the source of the data, the time they were elaborated, the context of the collection, etc. In CoCliServ we elaborated an important set of metadata in order to describe initially each narrative collected in the work package 1 because we didn't want to store and publish those narratives as is. In short, the metadata would describe who was interviewed, where it happened, when, by whom, in what context, what were the topics, what was the feeling about the climate topic, etc. So instead of having metadata describing a set of data, we have metadata describing each item in our collection, and we don't store the data itself which would be in the case of a narrative a conversation. And these metadata are our data. In our tool none of the attributes are mandatory, especially the identity can be a pseudo. The location recorded in the tool can also be altered afterward in order to scramble the information and strengthen anonymity.

It is important to note that the information collected is not necessarily the information published afterward.

The metadata model elaborated contains an important number of attributes which makes the work with a graphical interface difficult because of the need to display all the fields to fill in a single form, and tricks had to be found to bypass the cluttering of the display.

A second challenge came from taking into account sources other than narratives, like books, tv broadcast, news in newspapers, and so on. Some attributes can fit several types of sources but not all, like for instance an ISBN number. We had therefore to elaborate a form that can adapt itself according to an initial choice of source.

This is when we invented the generic word "*informion*" to designate the different sources of information. A narrative is an informion, a book is an informion, a paper is an informion, well at least they are in our database and our QGis interface.

So we have informions, and we have other types of data in our tables, i.e. what we call the parameters and the glossaries. As mentioned above in the users description the glossaries contain the possible answers to questions when there is a limited list of possible answers, they typically are what we see in dropdown lists. These are important because they somehow limit the freedom of the user, in order to avoid apparently different answers which are in fact synonyms, or out of topic answers. Let's remind here that no question in our tool is mandatory and the tool is made to record metadata only.

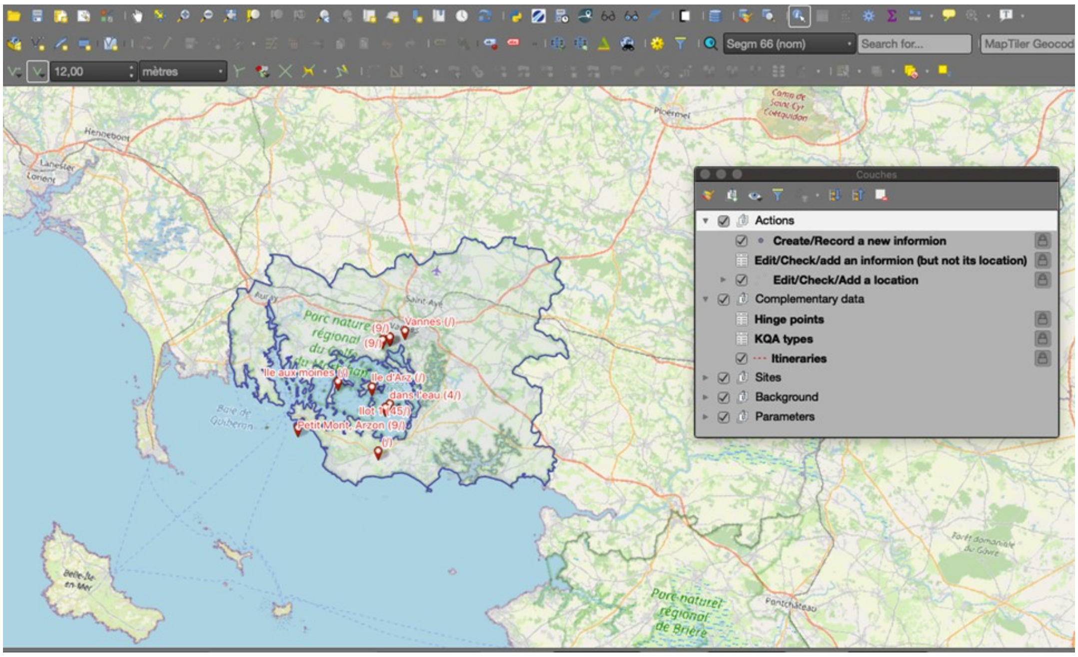
The locations in the informions

So we are here talking about the possibility to document field studies taking into account the spatial dimension. The informions therefore (usually) have a location and it took us time to decide what would be the 'place' of this geographical dimension, i.e. what location to record, and above all what would be its meaning for the informion. Is it the place where the surveyor would have met the respondent? The place where lives the respondent? A place the respondent is talking about? And in this case, what if the respondent talks about a country or the planet?

We have answered these unsolvable questions by creating a '&-to-n' relation between the informions and the locations, and we allow thus to associate one single informion to several places. We have also added the possibility to specify the spatial dimension of the place; is it a point or an area? And if it's an area it is possible to specify it's size. Finally, we have added the possibility to link the places together in a sequence, in order to represent a journey, like for instance the migration of a refugee.

Places also have their own characteristics, such as a description of the environment, the place (birth place, residence, work place, ...) in the interviewee's life, a name, sensitivity to climate change, etc.

As said above the metadata model developed in WP 4.2 lists an important number of attributes, but these are now shared between informions and locations.



Using the tool

On opening the project (the QGIS project) the user sees the map showing his/her work area and the already recorded information and places. There is also a background map which can be chosen and modified by the user, the places have labels. There is also a panel listing the layers composing the map set and the actions that the user can do.

The main actions are:

. Create/Record a new informion

. Edit/Check/add an informion (but not its location)

. Edit/Check/Add a location

So the user can record, modify or delete the collected information in different ways, and also of course check the stored information by clicking on a symbol on the map. Doing so a form will open and display the data. The same form can be used to edit or create new items. Places can have different roles in an informion, and additionally to their specificities they can be part of a sequence like for instance they can be stopovers in a journey, like for refugees but not necessarily, the sequence can be anything. This can be recorded by giving a sequential number to them. The system will sort them and draw a line connecting all the stopovers for a same informion.

Over the course of the project, we completely recreated the dynamic map tool several times before reaching this final state, and we feel that we now have something that reflects the data collection work of the qualitative approaches in the project quite well, and thus could be used in the future for similar work. Above all, it is a very flexible and versatile architecture, which allows for a certain diversity of uses.

When the data are recorded and when they are found in a large enough quantity, it could be envisaged to carry out statistical analyses taking into account the spatial dimension.

Art–science conjoint analysis context and highlights

CoCliServ's art-sciences conjoint analysis challenges are clearly expressed in the 5 case studies in their diversity and detailed richness as already expressed in D4.4: they represent opportunities for local consciousness-raising on climate related questions, along with forthcoming implementation of climate services at local, regional and international levels. As described in detail in D4.4 three papers have been published past year directly linked with the sites' described efforts (Krauß and Bremer 2020; da Cunha et al., 2020; Baztan et al., 2020). These papers are the first Arts and Sciences papers published in the dedicated journal “Climate Risk Management”, and they illustrate the first key point for our consortium and the whole community: how important it is to validate experimental local approaches with mainstream dynamics such as peer-review publication.

The second challenge is the room for improvement that appears once the peer review is validated for the experimental approaches linked with mainstream sciences. This room for improvement expands in three main directions: the processes and their methodologies; making social transformation intentions explicit; and linking local challenges with national and European Framework Directives related to climate services.

The third key point is to know the power of using art forms to represent local climate information. Now we know how local stakeholders engage in the process and how important they are for climate services; from here, we need to link arts and sciences with the other modes of representation and overall CoCliServ lessons learned. Art-based intervention has been proposed in the context of climate change for quite some time (Lippard 2007, Volpe 2018). This is not without pitfalls such as instrumentalising art, and reproducing dominant categories and codes through art (Miles 2010). Experiments have shown that through public participation and activism, art may be empowering, and may shift attention to issues that question dominant paradigms (Sommer and Klockner 2019).

Several dimensions have been identified for collaborations between art and science: new understandings and capacities within and across the arts and sciences involved (Gabrys and Yussof 2012); catalysing explorations of the scientific context and critical re-imaginations of research practices (Rödder 2017); helping to engage multiple senses and emphasizing social interaction within research practices; aiding participating researchers in thinking creatively (Jacobson et al. 2016); redesigning social relations to natural systems (Armstrong and Leimbach 2019); rearticulating politics and knowledge (Latour 2011); offering more effective approaches to engaging multiple publics in climate-compatible behaviour change; and engaging explicitly with the under-researched issue of the role of place attachment and local, situated knowledge in mediating the influence of climate change communication (Burke et al. 2018).

Capitalizing on these observations, we developed the working hypothesis that iterative art and science approaches have the potential for instigating and sustaining community dialogue through efforts to co-produce climate services. We saw art as essential for making the concept of climate services more meaningful in a specific place, and focused on narratives as an entry point for co-construction.

Developing a strong connection between art and science enables the re-articulation of the scientific description of the world (Latour, 2011). The CoCliServ sites, in their diversity, explored through their own local Arts and Sciences approaches polysemic concepts such as climate change and associated "services". Our investigation entailed examining the potential of art 'gestures' (Citton, 2012) and the 'practices of everyday life' (de Certeau, 1990) to facilitate cultural translation between different fields of knowledge and the associated diversity of priorities in bringing them to action.

While the five CoCliServ sites each have their own particularities to their approaches, the next section synthesizes the main lessons learned from the sites along with the commons points in the sites' processes, and the final conclusion. For full details please read the previous deliverables: D4.1, D4.2, D4.3 and D4.4.

Lessons learned and final conclusion

The 5 CoCliServ sites have been strongly proactive in WP4 and the related modes of representation, with an intense dialogue between site leaders and modes of representation referents. The main lessons learned are detailed below from both perspectives: the sites and the modes of representation.

Lessons learned from the modes of representation perspective

From the metadata and dynamic mapping perspective

Constructing and using a metadata model and a metadata tool such as the ones developed by Tasks 4.2 and 4.3 is not necessarily straightforward. The time-consuming aspects of preliminary tasks may mask the interest of the hypothetical future benefits. Some of the issues and challenges we met are addressed below.

Encoding metadata for the whole lot of narratives revealed too tedious a task for most partners, whether via the Excel spreadsheets provided or directly into the QGis-based tool developed by Task 4.3, even with the recourse to templates that could considerably simplify the task. Later advantages remained too unclear – and were indeed not demonstrated – to convince the project partners to really dive into this effort. The timing was also not ideal to do so, since the narrative collection and the metadata scheme proceeded and matured in parallel. The site leaders had already started to use their traditional methods of analysis when the possibilities that the metadata offered in this respect appeared more clearly. However, the prospective of visual representations of results was an incentive.

In many respects, we opted in this project for a resolutely open metadata model:

- no field was mandatory;
- new options could be added to drop-down menus;
- new metadata fields could be proposed;
- numerous fields accepted free text.

The obvious advantages of such a model are its flexibility, the freedom left to the metadata provider and the high degree of nuances that can be expressed. But this approach has also strong drawbacks. The fact that the scheme expands as time goes by hinders the comparison of narratives for which metadata have been recorded at different stages of its life. Empty fields may result in discarding a narrative from statistical studies. Free text cannot be automatically read and makes comparison between various narratives arduous. To guarantee a sensible information content, an easy analysis and a minimal comparability, a balance between flexibility and rigor must be achieved. Flexibility may be preferred as long as the scheme is under development (which was actually the case during CoCliServ) but at some point, the model must be frozen in order to be useable.

Data of a subjective nature are essentially different from the data treated by the physical sciences for which metadata schemes have been established for a long time. But even more crucially, the subjectivity of the researcher who will document a narrative will influence the metadata content, which will usually not be the case for metadata pertaining to physical measurements. Whether a number lies under a given threshold, for example, will not depend on the metadata provider, whereas an element of a narrative may be interpreted by one researcher as an allusion to a potential climate-related hinge point, and not by one of her/his colleagues. This provides metadata for narratives a relative nature of which users must be aware.

Due in part to the novelty of the approach, in part to the very different styles of practice, concepts and vocabulary of the researchers in their respective fields, developing a metadata scheme for narratives involved substantial communication and lasted for the duration of the project. The scheme that was progressively completed to meet the partners' expectations was only tested on some examples, not numerous enough to conclude if the concept was adequate, even less to document all the collected narratives and serve as an analysis or dissemination tool. Yet, it is hoped that the outcome of this pioneering exercise can be the starting point of future other projects.

GIS brings together various more or less sophisticated techniques of which cartography is probably the best known. Cartography produces rich and relatively easy-to-understand graphics to enlighten a discourse, but also opens the way to certain analyses by allowing the spatial dimension of studied problems to be taken into account. Geographers start by mapping a phenomenon and then use this spatialization to look for correlations with other aspects or other phenomena also mapped. As soon as the mapping is done, the locations are digitized and the associated data can benefit from computer processing of the digitized data. Although the process is common in human geography, it is only exceptionally used in the other human sciences. By attempting a hybridization between humanities and natural sciences, the CoCliServ project wanted to explore different unusual paths, including GIS.

The ambition of CoCliServ in relation of mapping was more than just produce beautiful illustrative maps for brightening up reports or to support meeting discussions with local communities. These were made as well of course, maps are a common tool in scientific discussions about environmental issues, and are presented in other deliverables. The plan was to explore the feasibility of producing a tool to dynamically share field observations from many types of sources (in fact, not only narratives) and ensure a maximum preservation of the collected information. In social science not every information can be saved and standardized, there is always a limit, even literature fails at capturing the ultimate personal feelings.

The ambition here was to develop a database model to push further the limits of the data capture from informal social sciences outputs. Therefore, our first logical step was to elaborate a metadata scheme with the field investigators (see task 4.2), the second was to produce a database model and the third one was to make a user-friendly interface that could be used by different types of users, dealing with different types of information. Of course, these three theoretical steps were explored simultaneously with lots of back and forth during the project. "Whether such a dream may really be a nightmare is another topic" (Peuquet & Marble, 1990).

As explained above, we needed to marry an IT tool with users who are not familiar with such technology in their usual activities. It has been tried before of course by other researchers (e.g. Caquard, 2011, Vivant et. al, 2014), and it is a never-ending task, since on one side the needs are always too specific and on the other side a versatile solution would most probably require a high level of computer literacy as it would remain something very abstract. The challenge is therefore to find the right balance between solutions that are very simple to grasp but quickly overwhelmed by the difficulty of taking into account the specificities of human reality, and very sophisticated solutions with a very good potential for abstraction but which are too complicated to learn and use.

We have come to a (temporary?) conclusion that mixing those opposite constraints might be feasible if:

- users are ready for a little learning.
- there are a few users responsible for some of the more difficult tasks
- someone is there to manage the system on a technical level

Addressing all of those questions drove Us to the Art–science conjoint analysis perspective.

From the Art–science conjoint analysis context

It's important to remember here, see D4.4 for full details, that for the purpose of this research we used Vaughan and Dessai's (2014) definition of climate services:

"The aim of climate services is to provide people and organizations with timely, tailored climate-related knowledge and information that they can use to reduce climate-related losses and enhance benefits, including the protection of lives, livelihoods, and property". When considering this definition, we focus on providing people with climate tailored knowledge, "people" understood as members of local communities. The central challenge we wished to address was that of "tailoring" climate knowledge and information for communities at the margins or at the core, who might not be -or might be- aware of climate issues.

Such tailoring of climate knowledge is closely associated with the ability to establish iteration (Dilling and Lemos 2011) and dialogue (Vaughan and Dessai 2014) between scientists and non-scientists in the course of knowledge production and use. Climate knowledge co-production, the "deliberate collaboration of different people to achieve a common goal" (Bremer and Meisch 2017) has been proposed for quite some time (e.g., Lemos and Morehouse 2005) to address challenges of initiating and maintaining such reiterations and dialogues. But what if this dialogue needs to be established on grounds other than those of climate change? Bremer and Meisch (2017) conducted an extensive mapping of the literature on climate change research co-production. They identify a series of eight "conceptual lenses" and call for a "self-reflexive transparency when using co-production concepts" to address the concepts' polysemy. Within their framework, CoCliServ work lies at the juncture of several objectives associated with these various lenses: we want to integrate non-scientists as co-investigators (extended lens); we wish to sustain interactions between climate science providers and users (iterative interaction lens); we pursue a goal of empowering local experience, and thus of local knowledge (empowerment lens); we recognize the need to facilitate social learning about climate issues (social learning lens); and we are embedded in a culturally-rooted goal to improve public service through the joint engagement of government agencies and citizens in the production of new knowledge (public services lens).

All these objectives are associated with acknowledging the current uneven distribution of access to, and benefits from, climate services development (Vaughan and Dessai 2014). For instance, Harjanne (2017) surveyed institutions related to climate services to identify how they justify the need for climate services (as a departure from climate science), and identified the following: global and widespread nature of the climate challenge; specific industry needs; socio-economic value; technological potential; and deficient supply and demand. We envision co-production of climate services, not because we perceive co-production as a "value in itself" (Voorberg et al. 2015), but because we see co-production as a means to create and nurture sustained interaction with communities while contributing to their empowerment. We wish to explore means for correcting the inequitable distribution of climate change knowledge for action.

We hypothesized that part of this uneven distribution may reflect that not all communities are equal and some are facing such immediate challenges that climate change may be invisible to them. This hypothesis called for working to shift awareness to the actual or potential, current or future, connections between everyday non-climate concerns and climate issues. Such a shift called for a practical intervention, centered on local culture. We chose to work hand-in-hand with artists to conduct such an intervention, as art is well identified as an approach to make visible the "invisible or almost-visible" phenomenon of climate change (Knebusch 2008). Art is also identified as facilitating access to narratives in general, and climate narratives in particular (Roosen et al. 2018).

Lessons learned from the sites perspective

Bergen, Norway

On three different occasions Bergen's partners introduced groups of children and adults to the historic Norwegian calendar and invited them to create their own primstav, for their own lives, and through this, engaged them in thinking and conversation about the rhythms of their year, seasonal adaptation, climate adaptation and climate change.

Around 150 primstavs were made, one might object that at this pace all we get through this exercise are seasonal clichés, well established from preschool's dexterity developing drawing exercises and word processor software's` stock photos, and not actual representations of the rhythm of their year, and this is probably to some extent correct. Still, the main objective of the exercise is to get started some reflections on (i) how we do different things at different parts of the year, (ii) that this has been different at different times in history, e.g. the time of the primstav and now, and (iii), that this might change again in the future with for instance climate change. Based on the conversations we had with both the children and the adults during the exercises and the primstavs made, we think the exercises worked well. As noted, we find the primstav to be a powerful image, a concrete object making concrete what living with seasonal rhythms' can be, suggestive in the context of climate change and climate adaptation; an object "good to think with" (Levi-Strauss 1962). We felt both the adults and the children were fascinated by the primstav and excited about the task of making one for their own life, and that they found the suggested connection of this to climate change and climate adaptation to be interesting.

We found that, as the exercise is set up now, children younger than seven have some trouble responding to it, though of course, they also seemed to enjoy the drawing. On the other end, we found that most adults really enjoyed it and responded very well to the primstav and climate adaptation analogy, and to the drawing and woodwork. For full details please see D 4.4.

Dordrecht, the Netherlands

The Dutch partners works with both ‘knowledge directors’ and creatives, such as graphical designers, animation, web design and development and sound specialists, applying this on climate change and adaptation specifically to co-develop a visual workshop approach to help participants in their vision and scenario design (focus: before and during the scenario development), designing future visions and scenarios for timescales up to 30 years can be very challenging, for both experts and non-experts. A clear advantage of this approach is that it helped facilitate the research process and local design of climate adaptation visions, options, and scenarios. It helped bridge the disparate worlds of different scientific disciplines and different stakeholder groups, including policymakers, residents, and researchers. This type of art approach also involved a very tactile, physical mediation, which stimulated active discussion and creative work during the workshops and put all participants on an even playing field. The latter is particularly important, for instance if there are tensions, or perceived barriers or differences in expertise between participants. The line art also offered much, uncluttered white space, enticing people to add their own contributions. The streets and timeline were printed on large cardboard wall posters, which allowed multiple participants to work on them. The collaboration between the research team and the graphic designers in developing the artwork also went very smoothly. One might speculate that graphic designers are used to working with a wide range of clients and purpose-driven assignments, compared to more art-driven processes such as painting or theatre. Of course, the specific situation in the case study and Dutch team also helped: the Dutch research team and project leader are very interdisciplinary, and Studio Lakmoes is specialised in knowledge visualisation. All in all, this led to a very useful and productive process.

Several challenges and limitations can be observed as well. Graphic designs and line art worked well to represent physical elements that are easily visualised into recognizable objects, such as houses, people, clouds, etc. However, the narratives also involved more nebulous notions such as identity, history, sense of community and emotions such as hope and fear. Combination of the visual art with narrative handouts (short descriptions with quotes per vision) worked well to cover this. Combination with other art forms might be useful as well. The approach was also successful in combining the natural science and social science dimensions of adaptation, but in line with the previous point, might have more difficulty with humanities-related aspects, unless combined with other forms. Regarding the human dimensions of graphic design in art-science collaboration, while this approach worked very well, one could also argue that it is fairly goal-directed and instrumental. It helped elicit the 'insider perspective' of the local communities. Other art forms might be better at providing an 'outsider perspective'; e.g. an artist observing the proceedings and providing his or her own unique perspective on that. For full details please see D 4.4.

Jade Bay, Germany

The core in Jade Bay is the photo-documentation of the ethnographic work in the coastal village of Dangast, the most prominent tourist location and oldest sea bath at this North Sea coast. The North Sea coast in general and the Jade Bay specifically are very popular motifs for tourists and artists alike. There are literally millions of photos of the sun rise, of the sun down, the fog, the tides, simply everything. The challenge was to find out what is missing or what could be added, what makes a difference, where is the blind spot of this totalizing visualization. Artists live and work in a rhythm different from academics. “Hiring” an artist for a project involves complicated management of time and money. Furthermore, it is impossible to predict in advance if the collaboration will be successful. Art is a process which is dependent on intuition and serendipity, as is ethnography to a certain degree.

In practice, the photo documentation of the ethnographic fieldwork was an interdisciplinary and continuous dialog between art & anthropology. A documentary is not just a depiction of something that already exists, but it is an active process that produces something new. Photography did not only add something to the body of ethnographic work that already existed; instead, it turned into a collaborative activity with its own dynamic and new insights.

The anthropology & art cooperation was different from the one with climate science. The communication between science and anthropology was exclusively about the production and exchange of data and information. As an anthropologist, I always felt uneasy about reducing complex field experiences and long conversations or interactions into “data” which were either “useful” or either “right” or “wrong”. The photographer-artist shared the same feeling and unease, from the beginning: what kind of data did he have to produce? What kind of product was he expected to deliver? It is difficult to get rid of this kind of thinking, which is common in interdisciplinary projects. In the art & anthropology collaboration, we discussed this kind of pressure from the beginning and started to reset the default position. We both had already worked in and about various landscapes, and we compared our methods how we explored these landscapes, what it takes to understand, to see and to feel the specific atmosphere of a territory, understood as an amalgam of the physical, the geological, the social and political atmospheres. Our explorations were focused on the blind spot; we want to make explicit the phantoms and ghosts of the Anthropocene, as Tsing et al put it, in a specific combination of word and picture.

Art is guided by art. Dangast as a field site turned out to be instructive. The work of Franz Radziwill actually served as an inspiration. In his paintings, he linked different elements of reality in new ways which made explicit new aspects of the coastal landscape and the lifeworld of modernity with its environmental degradation. We intend to do the same for climate change.

Photography is about light, and light is linked to weather and time. I did not know about the importance of light, even though the light of the Northern coast is one of the reasons why people love to spend their time in this area.

We absorbed local climate information in many ways; as daily weather, in talks about the weather, in deciphering historical landmarks, in interviews etc. People were curious in our work and easily understood that we want to depict climate change beyond statistics and numbers. Our project served as an entry point for debating what it means to live in a coastal landscape with a changing climate. For full details please see D 4.4.

Kerourien, Brest, France

A co-production work focused on collecting narratives is the core for the Kerourien, Brest, France partners. This was an ad hoc process, which evolved along the way. We present our approach and associated observations as the first part of our results, describing the organizational stages and observations on procedures and substance.

The initial step of our co-production process allowed us to anchor our actions in local stories and relate directly to our partner community and its values. This allowed us to free the co-production team from dominant (and technocratic) climate change and adaptation discourses. Rather than adopting the pervading culture represented in the climate literature available to the community, we adopted narratives associated with everyday life, hardships, the joys and pain of migration, and engagement for greater justice.

Through the lens of priority setting, climate service co-production has much to learn from participatory research and participatory planning. For instance, one aspect we did not address explicitly in this experiment in co-production was that of gender. In the realm of participatory research there are many analyses showing that one should be explicit about gender and other identity dynamics at play – the "Whose voices? Whose choices?" questions that need to be answered (Cornwall 2003). In the case of climate service co-production, the dominant discourse may totally blind co-producers with its technocratic, pseudo-neutral, scientific stance; it seems too often to consider gender, race, class, and other social categories, as not necessarily part of what deserves attention. Within the realm of climate change, our results point to "the importance of (re)politicizing co-production by allowing for pluralism and for the contestation of knowledge" (Turnhout et al 2020, pg. 15). As Krauss (2020) writes, "a focus on narratives shifts the attention from the impact of climate on society to the myriad of entanglements between human and non-human actors in a changing climate" (pg. 3). This shift in focus will allow us to ground further steps of climate service co-production in the priorities of those most vulnerable to the vagaries of the world.

Finally, paying attention to local stories and the role of weather and climate within these stories led us to the realization that locally place-based climate service co-production may actually entail working with multiple locations and associated issues. Co-production challenged our routines (Krauss 2020). It pushed us to reconceptualize "place" as extending beyond the circumscribed location where our co-production partners were living at the time. This opened up a rich perspective in terms of climate service co-production. In the course of our work, place became a relational concept, the definition of which belonged to the members of the co-producing community – what mattered what their sense of place (see Stedman 2003). Sense of place is an integrative concept (Saarinen et al. 1982), and it carriesthe characteristics of both the environment and of the individual or group perceiving it. Sense of place connects with place attachment, and others have shown, as we observed, how memory is critical for migrant populations' relationships to places (Rishbeth and Powell 2013). By adopting this extended concept of place, the co-production team had to accept that knowledge transcends national boundaries, and that time scales may relate to individual trajectories of past, present, and hoped-for futures. Huot and Liberté-Rudman (2010), analyzing the interplay of occupation, place, and identity, propose that individuals perform their identity in relation to place and occupation. This resonates with our results and the dynamic nature of the judgement individuals expressed of the place where they live and of the (now imagined) place that they once left, and to which they long to return. The status of place shifts through time, as a manifestation of changes in context, occupation and identity. Place-based co-produced climate services in such situations need to be reinvented in order to offer information that is dynamic, reconfigurable, multi-layered. This is another central challenge for the climate service co-production research agenda. For full details please see D 4.4.

Morbihan, France

For Morbihan's partners the aim of the WP4 was to engage local stakeholders, through several forms and routes constantly aiming to a greater collective construction bringing its load of challenges and good surprises. Each of the choices valorizing knowledge produced within the other work packages. The main outputs are: a collaboration with the designer to produce creative tools to support the animation of workshops, the project of a long-term exhibition, the realization of a small itinerant exhibition with climate data vulgarization panels and a comprehensive storytelling exercise and connect them to the metadata and dynamic mapping final tool.

The whole artistic process is embedded in extracts of the multiple interviews led by the social research team and in the results of the prospective workshop. All the information shared during the workshop were nourished by the presentation of local climate data and services.

Artistic media is the result of a complex combination of its creator perception, personal artistic interpretation and the message the artist wants to convey. Moreover, most of the artists engaged in the Morbihan project, produce in-situ creation. The uncertainty of the location for the long-term and short-term exhibition was perceived as a difficulty for the artists as well as, maybe, a misunderstanding or mismatch between the expectations of the project and the creative process of the artists.

The will of conducting a collective process on the artistic aspect of the project has enabled the team to be confronted with various difficulties with lessons learned that will be detailed in the next section.

The difficulty of entering in a horizontal management dynamic with individuals from different backgrounds and sensitivities has, at several occasions, risen the question of who is in charge of the final decision and how should those decisions be taken. The difficulty of that being reinforced by the constraints put by the covid19 context of only virtual meetings. It is highly probable that the group dynamic would have taken another turn, if only physical meetings would have been possible to organize. In the Morbihan case, as five artists were gathered around the projects, several creative sensitivities were asked to work together with a designer and a scientific team on different projects and perspectives leading to some misunderstandings and possible frustrations.

A great impulse was given at the start, thanks to a great coordination work done by the designer and the local partner, Clim'action. The time would then expose to us that the will and expectations of some individuals in the dynamic had given contradictory information on the possibilities of the project. Realigning everyone on a same understanding of the project's objective and constraints did take a long time but having a common long-term objective turned out to be a strong block to build on.

As the main objective was to develop the artistic work on the basis of the material collected through the interviews and workshop, we got confronted with the weak presence of some high-stake subjects such as the loss of biodiversity, acidification of oceans or changes in the rain regimes. The question and debate were then raised on the mission of the art & science project: i) to only illustrate the concerns raised by the interviewed stakeholders considering those will be the main ones of interest for the population of Vannes, ii) to extend and inject subjects identified as key ones by the scientific or artistic teams to extend the horizons of the visitors.

The development of artistic works is found to be an effective way to convey messages of future narratives. The maps and creative tools helped the participants to the workshop to apprehend the discussion with other approaches. The development of the Cataravane and the storytelling exercise has led to multiple exchanges and discussions among the artistic committee and created the possibility to discuss about our visions for the future. In order to push those exchanges out of the boundaries of the committee, multiple animation activities were planned to accompany the art & science process. The objective would have been to organize animation at the end of the exhibition, seizing the potential benefits from the immersive experience to further discuss spectators' perception of climate change and will of action or decision. Unfortunately, the difficulties of setting up the exhibition both administrative (due to the covid) and human (see Challenge - The human dimension) did not allow us to carry out these animations, for lack of time and courage.

The coastal path turned out to have a fundamental role as an apt location for the artistic exhibition. Propositions such as the “Pathway of possibles” allow us to argue that artistic work can also become chronotope themselves. These works result from interpretations of the collectively-built narratives of past, present and future change, that are converted into physical elements to allow people to follow the ongoing changes in the territory. Scientific researchers and artists analyze scientific information collectively to capture the spatial and temporal dimensions of current transformations, which are then communicated through artwork acting as markers, for instance, of expected sea level rise or estimated coastal erosion in the future. This “sneak-peak” into the future, as well as the ability to observe the speed of these changes through these new chronotopes, could inspire community-led transformative practices.

The COVID19 situation has banned any meetings on site and between artists whereas they have the habit to discuss creative projects around a table in a more intimate and favorable environment. The horizontal management that was implemented was still, in the end, constrained by the budget discussion, which was in the hands of the scientific team or under the responsibility of the local partner, changing the rule of that will of horizontal management. Those two elements are usually easily discussed through in-real interviews by formal and informal discussion. The distance created by the virtuality of the meetings has emphasized difficulties or weaknesses of the inclusive process, which could have been dealt better with in-real meetings. Moreover, the artistic process mobilizes individuals with different sensitivity and expectations on the project and its development. At various moments artists have felt excluded from the process, whereas again, in-real meetings would surely have helped to avoid this kind of situation.

The project has benefited from the contacts and existing networks of artists of the site, involved in climate/environment awareness art performance. This dynamic was a real opportunity and has led to the multiple results detailed in this document. However, it is important to notice that in parallel of the official communication, happening within the artistic committee, alternative communication and dynamics, within the pre-existent network, were creating other narratives to the project and its ambition. For full details please see D 4.4.

Final conclusions

Representations and their associated modes are at the very core of CoCliServ, working for: turning "matters of fact" into "matters of concern", and using narrations to transcend oppositions in representations of sciences and local knowledge, nature-culture, global-local, in order to develop climate services.

The figure below represents the complexity we worked within from the 2017 catalog and early stages of CoCliServ to the 2018-2021 site-based implementation.

metadata standardisation (lead IASB-BIRA) dynamic mapping (lead ULB/IGEAT) art–science conjoint analysis (lead UVSQ-CEARC) ** citizen sciences > Diana > in/to WP 5* ** science mediation formats (lead HZG) > Insa > in/to WP 6*	Bergen Dordrecht Gulf of Morbihan Jade Bay Kerourien

	Bergen	Dordrecht	Morbihan	Jade Bay	Kerourien
Metadata	Visio side meetings, test beta versions	Visio side meetings, test beta versions	Workshop, visio side meetings, test beta versions and final version	Workshop, visio side meetings, test beta versions	Visio side meetings, test beta versions
Dynamic Mapping	Visio side meetings, test beta versions	Visio side meetings, test beta versions	Workshop, visio side meetings, test beta versions and final version	Workshop, visio side meetings, test beta versions	Visio side meetings, test beta versions
Art-Science	From/to WP 1, 2, 3	From/to WP 1, 2, 3	From/to WP 1, 2, 3	From/to WP 1, 2, 3	From/to WP 1, 2, 3

Figure: from the 2017 catalog -in orange- to the 2018-2021 implementation -in green-.

The complexity of the starting point and the exigence of the learning process brought the partners through three key levels of progression that we consider major contributions for the climate services community:

(i) Climate Services do not necessarily appear in the top priorities of the population. WP4 shows clearly that the modes of representation and its associated processes contain the priorities of society as a whole. Standardizing CoCliServ results in protocols to connect the populations' priorities with climate services, and from there climate services with the most pertinent and integrative local modes of representation.

(ii) In order to have access to and represent the complexity related with climate services and its connection with society as a whole, we found a way to create an integrative context for the 3 main CoCliServ modes of representation: metadata, dynamic-mapping, and arts. In this we learned to be explicit in the related processes at play in the emergence of new forms of representation that link and integrate what was previously separated for reasons of disciplinary inertias.

(iii) Local particularities and constraints clearly appear in the efforts of CoCliServ WP4. Universal concepts related to climate services can be applied locally with long-term perspectives only if they are concordant with local values and "acceptable" processes.

The chance to have a formal context for "modes of representation" as facilitated by CoCliServ enabled us to recognize the importance of making social transformation intentions explicitly linked with local challenges and with national and European Framework Directives related to Climate Services. We reiterate the importance of having local stakeholders engage in the climate services process in order to forge common commitments and incorporate what can be polarized value perspectives, throughout society as a whole.

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