EU-CIRCLE

A pan-European framework for strengthening Critical Infrastructure resilience to climate change

D4.8 EU-CIRCLE CI RESILIENCE METADATA

Contractual Delivery Date: 02/2018	**Actual Delivery Date**: 10/2018
Type: Document, report	**Version**: v1.0

Dissemination Level: Public Deliverable

Statement
This report, D4.8 EU-CIRCLE CI Resilience Metadata, provides approaches that were done in Task 4.6 for the development of methodologies to define metadata for WP4 resilience related datasets. The deliverable extends the already proposed approaches and definitions from WP3 and D3.6 in order to cover the resilience datasets. Data specifications for resilience data are also included in this report.

Preparation Slip

	Name	Partner	Date
From	Michael Skitsas	ADITESS	08/10/2018
Reviewer	Nenad Petrovic	UVG	08/10/2018
Reviewer			
For delivery	A. Sfetsos	NCSRD	10/10/2018

Document Log

Issue	Date	Comment	Author / Organization
V0.1	15/02/2018	Deliverable Structure, ToC	ADITESS, NCSRD, UVG
V0.2	15/05/2018	Definition of metadata format and encoding	ADITESS
V0.3	30/05/2018	Definition of datasets according the RAT tool	ADITESS, UVG
V0.4	31/07/2018	Finalization of data specifications, link with RAT tool	ADITESS, UVG, EUC
V0.5	15/09/2018	First draft of the deliverable	ADITESS
V1.0	28/09/2018	Address comments based on internal feedback	ADITESS

Executive Summary

Metadata is a set of data able to describe the content and make a data set searchable and then shareable. This deliverable provides guidelines for the development of the metadata files for the EU-CIRCLE CI Resilience data.

The guidelines aim to cover two type of data sets, the end-user's questionnaire and the resilience indicators. Both datasets are used by the Resilience Assessment Tool (RAT) for the calculation of CI Resilience Index. The structure of metadata is based on a general template (baseline metadata) as proposed and defined in D3.6 Risk Model Metadata enhanced with specific fields for each type of data.

Furthermore, data specifications for the questionnaire and resilience indicators are presented in this document in order to assist the development of the data sets and define the data structures for storage and access.

Contents

1   Introduction

The deliverable D4.8 *CI Resilience Metadata,* presents approaches that were done in Task 4.6 from the WP4 of the EU-CIRCLE project. The main results of D4.8 are the development of methodologies in how to define metadata for the WP4 datasets. In general, metadata give information about the data, such as who made the data, what are the data dimensions, references to algorithms etc. Examples of relevant metadata attributes are also given in this deliverable.

The metadata is defined as structured information able to describe an information resource or data set. Metadata is often called data about data or information about information. The purpose of metadata is to make the data discovery easier, organise the data and eliminate the data duplication.

In EU-CIRCLE project and WP4 we identify two main data sets that will be accommodated with metadata:

- **End-User Questionnaire:** There are two types of data within this data set: data related with the development of the questionnaire and data related with the collected responses. The second type of data will be used by the RAT (Resilience Assessment Tool, D4.5) for the calculation of the resilience index. For both types of data, the necessary fields and structures have been defined and included in the general EU-CIRCLE metadata approach.

- **Resilience Indicators:** The second dataset that this deliverable cover is related with the development of RAT tool and the structure of Resilience Indicators and sub-indicators.

Additionally, as part of the metadata, this deliverable also presents the EU-CIRCLE data specifications for the above datasets.
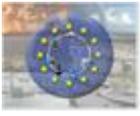
2   Methodology

2.1   Link with D3.6 Risk Model Metadata

The purpose of this deliverable is to define the approach of development EU-CIRCLE CI Resilience Metadata as developed in several tasks of WP4. In particular, this deliverable an extension of the proposed approach of D3.6 where the guidelines for Risk Model and CI representation metadata have been presented.

For each metadata record, the methodology that D3.6 (Chapter 3) presents will be followed. Initially, the author will be asked to give the baseline metadata and similar with risk model and CI representation the special sections related with resilience will be attached.

However, as the resilience analysis is the last part of the EU-CIRCLE approach process, a complete record of metadata will be provided. Specifically, the resilience assessment will be based on hazards, CI representation, risk models, the output of EU-CIRCLE analysis tools and end-user questionnaires. For all these datasets, users will provide the information for all the appropriate sections within a metadata record.

2.2   Metadata Structure and Encoding

Metadata is a structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource [NISO 2004]. The challenge is to define and name standard metadata fields so that a data consumer has sufficient information to process and understand the described data without the need to access the actual data sets.

INSPIRE XML Encoding of ISO metadata

In INSPIRE, the encoding of metadata is based on the ISO Standards [ISO 19115], [ISO 19119] and [ISO 19139]. The abstract standards [ISO 19115] and [ISO 19119] provide a structural model and specify the content of the set of metadata elements used in INSPIRE while the [ISO 19139] standard specifies the XML encoding of [ISO 19115].

Metadata File Format – JSON

Another metadata file format that can be found is the JSON format. JSON is a lightweight data-exchange format that is very easy to read, parse and generate. Based on a subset of the JavaScript programming language, JSON is a text format that is optimized for data interchange. JSON is built on two structures: (1) a collection of name/value pairs and (2) an ordered list of values. JSON format is required by the Open Data Policy for the development of metadata.

EU-CIRCLE Encoding

In EU-CIRCLE project metadata will follow an XML encoding based on INSPIRE guidelines with the addition of specific fields to fulfil the requirements of the project. Such fields will be the resilience related metadata as well.

Regarding the data specification and the specific data models that are using in EU-CIRCLE project (i.e. development and fill in the questionnaire, resilience indicators) other formats can be used. In particular, for the asset class repository, a JSON encoding will be followed.

3 EU-CIRCLE CI Resilience Metadata

Similar with D2.4 and D3.6, every dataset within EU-CIRCLE should be accompanied with a metadata file following the guidelines described in metadata related deliverables (D2.4, D3.6 and D4.8). As described in D3.6, the file that represents the metadata is in an XML format with filename as DATAFilename_metadata.xml.

The WP4 is related with resilience and one of the goals is to develop the Resilience Assessment Tool. Through this tool, the CI climate change resilience index will be calculated. In this chapter, we extend the proposed guidelines for the development of metadata for each dataset of EU-CIRCLE project.

The two main datasets that this task and deliverable is considering are the end-user questionnaire (both the development of the questionnaire and the response of end-users) and the resilience indicators. The questionnaire along with the CIRP (or other EU-CIRCLE analysis tools) are forming the input to RAT towards the calculation of the Overall Resilience Index.

In the work under the Task 4.6 of WP4, we extended the already defined approach (D3.6) for the development of the metadata. The approach has a general template for metadata (baseline metadata) that applies in all the types of datasets and then for each type, user will be able to fill the specific topics related with the type of data. In D3.6, Geo-spatial data (related with the representation of CI and the assets class repository), Risk Modeling (including the damage functions) and the EU-CIRCLE Analysis results are covered. In this section, metadata related with Resilience Assessment Tool are covered.

3.1 Baseline Metadata

As presented in D3.6, the resilience metadata will include the baseline information. The list below presents the basic fields (sections) that baseline metadata covering.

- Naming Convention
- Metadata Reference Information
- Resource Identification
- Keyword
- Temporal Reference
- Data Quality
- Access and Use level
- Responsible Party

3.2 EU-CIRCLE Resilience Assessment

The EU-CIRCLE resilience assessment has three types of data: the end-user questionnaire, the EU-CIRCLE analysis output (CIRP software) and the indicators that are used for the calculation of the Overall Resilience Index. The EU-CIRCLE analysis is already covered in D3.6.

3.2.1 End-User Questionnaire

Each CI that want to use the RAT tool for the calculation of Resilience Index, will be asked to fill the end-user questionnaire related with resilience. Details about the development and the sample responses are
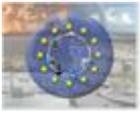
presented in the next section of this deliverable. In this paragraph, we provide the required fields for the development of the metadata file to describe the questionnaire.

Field Name	Field Description	Field Type	Acceptable Values
questionnaire	The ID of questionnaire in the system	Integer	
name	The name of the author (user) that fill the questionnaire	String	
position	The position of this person in the organization	String	
dateType	The type of the date. New response, update existing questionnaire	String	
date	The date of filling the questionnaire	Date	ISO 8601
description	The description of the questionnaire. This field will be field by the operator in order to describe within a single paragraph the purpose of the questionnaire	Text	Free text
associateFile	Include any files as outcome of the analysis	Filename and locator	

Additional, several fields related with the questionnaire can be also included in this section.

| Field Name	Field Description	Field Type	Acceptable Values
questionnaire	The ID of questionnaire in the system	Integer	
name	The name of person (contact person) that is responsible for this instance of questionnaire. The main author	String	
position	The position of this person in the organization	String	
email	Contact details of this person	String	Valid email
creationDate	The date of creation of the questionnaire	Date	ISO 8601
revision	The revision number of the questionnaire	Integer	
revisionDate	The date of last revision	Date	ISO 8601
title	The title of the questionnaire	Text	
description	A short description of the content and the purpose of the questionnaire	Text	Free text
keywords	Several keywords that characterize the questionnaire	List (String)	
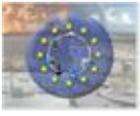
| questions | The number of questions | Integer | |
| time | The estimated required time for completion of the questionnaire | Integer | Minutes |

XML Example

```
<eucircle-resilience>
    <end-user-questionnaire>
        <questionnaire>1</questionnaire>
        <name>John Smith</name>
        <position>Business Continuity</position>
        <dateType>Creation</dateType>
        <date>2018-07-15T15:53:00</date>
        <description>
        Short description about the questionnaire
    </description>
        <associateFile>n/a</associateFile>
    </end-user-questionnaire>
</eucircle-resilience>
```

3.2.2   EU-CIRCLE Resilience

The second part of resilience metadata section is the indicators and the execution of RAT for the calculation of resilience index. After each exercise, the user will be asked to fill the fields below in order to have a record of the activity as well as the possibility to search among resilience assessment exercises that held previously.

Field Name	Field Description	Field Type	Acceptable Values
questionnaire	The ID of questionnaire that is used. Note, this ID refers to the response that is captured and not to the questionnaire as definition.	Integer	
analysis	The ID of the analysis that is executed and used in the resilience assessment.	Integer	
date	The execution date of RAT tool	Date	ISO 8601
description	The description of the analysis	Text	Free text
purpose	The purpose of the analysis	Text	Free Text
index	The overall index value	Decimal	Range 0 to 10
capacity	The capacity indices. An array that holds the five considered capacity indices.	Array (Decimal)	Range 0 to 10

XML Example

```xml
<eucircle-resilience>
    <end-user-questionnaire>
        <questionnaire>1</questionnaire>
        <name>John Smith</name>
        <position>Business Continuity</position>
        <dateType>Creation</dateType>
        <date>2018-07-15T15:53:00</date>
        <description>
            Short description about the questionnaire
        </description>
        <associateFile>n/a</associateFile>
    </end-user-questionnaire>
    <resilience>
        <questionnaire>1</questionnaire>
        <analysis>3</analysis>
        <date>2018-07-19T13:23:00</date>
        <description>Short description about the resilience exercise</description>
        <purpose>This exercise is contacted for the needs of new adaptation measures</purpose>
        <index>8.5</index>
        <capacity>
            <anticipatory>8.01</anticipatory>
            <absorptive>7.3</absorptive>
            <coping>9</coping>
            <restorative>8.9</restorative>
            <adaptive>8.6</adaptive>
        </capacity>
    </resilience>
</eucircle-resilience>
```

4 EU-CIRCLE Resilience Data Specifications

In this section we summarize the data structures of the data required for the development of the Resilience Assessment Tool. The methodology is based on resilience indicators that are classified in five categories: Anticipation, Absorption, Coping, Restoration and Adaptation. Additionally, to execute the resilience analysis the input from end-user questionnaire and EU-Circle analysis tools is required as well.

For the implementation of the Resilience Data Specifications model and the developing of the RAT tool (as a web tool or other software tool) additional system fields such as object type, timestamps (insert, update), system id, user, etc. will be stored as well.

The first part of collected data for the calculation of CI resilience is the end user questionnaire. In this paragraph, we aim to define the structure of the questionnaire and give the user a guideline to prepare the questionnaire. The table below summarizes the required fields for each one of the questions.

4.1 End User Questionnaire

4.1.1 Questions

| Field Name	Field Description	Field Type	Acceptable Values
questionID	The question ID. This id is unique for each question within a questionnaire.	Integer	Auto Increment number
parent	If the question is a sub-question the parent question ID should be given.	Integer	
category	Resilience category	enum	Anticipation, ….
question	The description of the question.		Free text
answerType	To describe the type of answer	enum	i.e. multiple choice, multiple answers, free text, numeric…)
choices (id, des)	A tuple that contains the id and the description of a possible answer (multiple choice type)	(integer, text)	
answer	Depending on the field type, the answer can be vary.	answerType	value of the answer
units	In case of metrics, this field will described the units where the answer should be given	text	
excluded	This field indicates the exclusion of the question during the calculation of the resilience indicator	Boolean	True/False

JSON Example: Questionnaire

```json
[
  {
    "id" : 1,
    "parent" : null,
    "category" : "ANTICIPATION",
    "question" : "Select the all hazards that for the time being included in your resilience plans",
    "answerType" : "Multiple",
    "choices" : [{
      "id" : 1,
      "decription" : "Heat waves",
      "type" : "boolean"
    },
    {
      "id" : 1,
      "decription" : "Heat waves",
      "type" : "boolean"
    }],
    "units" : null,
    "excluded" : false
  },
  {
    "id" : 2,
    "parent" : null,
    "category" : "ANTICIPATION",
    "question" : "Equipment and procedures for hazard mitigation exist",
    "answerType" : "Boolean",
    "units" : null,
    "excluded" : false
  },
  {
    "id" : 3,
    "parent" : 2,
    "category" : "ANTICIPATION",
    "question" : "How many climate related hazards (defined in scenario) it covers",
    "answerType" : "Integer",
    "units" : "Number",
    "excluded" : false
  }
]
```

4.1.2 Response

Field Name	Field Description	Field Type	Acceptable Values
questionID	The question ID that answer is for	Integer	
answer	The value of answer, in case of multiple answers, this field will be an array with the tuple of answer (id, answer)	answerType (or array)	
(choiceID , answer)	For multiple answer questions	tuple	
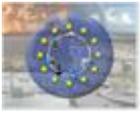
While the table in section 4.1.1 gives a guideline for the development of end-user questionnaire, the table in this paragraph gives the required fields to collect the response of a questionnaire.

JSON Example: Questionnaire Response

```json
[
  {
    "questionID" : 1,
    "answers" : [{
      "choiceID" : 1,
      "answer" : true
    },
    {
      "choiceID" : 2,
      "answer" : false
    }]
  },
  {
    "questionID" : 2,
    "answer" : true
  },
  {
    "id" : 3,
    "answer" : 3
  }
]
```

4.2   EU-CIRCLE Analysis Tool Input

The second part of required input for the analysis is about the results of the EU-CIRCLE analysis tools (i.e CIRP). In order to achieve the integration with the RAT (i.e output of CIRP as input to RAT) we define the structure below.

Field Name	Field Description	Field Type	Acceptable Values
fieldID	The id of the field	integer	Auto increment number
source	Indicate whether the analysis is done using CIRP or other tool	String	Enum with available and acceptable sources
category	Resilience category if available	enum	Anticipation, ….
description	Description of the field	test	
valueType	The value as a result of the analysis tool		
unit	The units of the value		

The definition of a data instance is presented in the table below.

Field Name	Field Description	Field Type	Acceptable Values
fieldID	The id of the field	integer	
value	The value as result of the EU-CIRCLE analysis tools	valueType (from table above)	

JSON Example: CIRP Input Definition

```
[
  {
    "id" : 1,
    "source" : "CIRP",
    "category" : null,
    "description" : "Number of climate related hazards impacting area of CI (according to scenario)",
    "valueType" : "Integer",
    "unit" : "Number"
  },
  {
    "id" : 2,
    "source" : "CIRP",
    "category" : null,
    "description" : "Time that asset is not able to serve its intended function",
    "valueType" : "Integer",
    "unit" : "Hours"
  },
  {
    "id" : 3,
    "source" : "CIRP",
    "category" : null,
    "description" : "Cost of asset damage",
    "valueType" : "Decimal",
    "unit" : "EUR"
  },
  {
    "id" : 4,
    "source" : "CIRP",
    "category" : null,
    "description" : "Loss of performance for certain hazards level",
    "valueType" : "Integer",
    "unit" : "Percentage"
  }
]
```

JSON Example: CIRP Input Values

```
[
  {
    "fieldID" : 1,
    "value" : 4
  },
  {
    "fieldID" : 2,
    "value" : 20
  },
  {
    "fieldID" : 3,
    "value" : 10000
  },
  {
    "fieldID" : 4,
    "value" : 80
  }
]
```

4.3 Resilience Indicators

The core functionality of the RAT tool is the calculation of several resilience indicators (based on user's input, either from Questionnaire or EU-CIRCLE analysis tools).

As already mentioned, the structure of the RAT tool is based on five resilience categories: Anticipation, Absorption, Coping, Restoration and Adaptation. For each category, a resilience indicator will be calculated and the final resilience indicator will be a function of these categories. The following tables present the approach to define and develop the methodology for the calculation of such indices.

4.3.1 Resilience Index (i.e. Anticipatory Index)

Field Name	Field Description	Field Type	Acceptable Values
id	"Resilience Indicators": This field will contain the description of the resilience indicator	String	
class	The classification of the resilience indicator	enum	Anticipation, …
description	The description of the indicator	Text	
indicator	This field contains an object that describes the categories and subcategories among with the calculation of sub-indices.	Resilience Category	
weighType	Describe the methodology that is followed to set the weights between the sub-indices for the calculation of resilience index	String	Among available methods, i.e. UNIFORM, CUSTOM, etc..

4.3.2 Resilience Indicators

Field Name	Field Description	Field Type	Acceptable Values
id	The id of the field	integer	Auto increment number
description	A text description of the resilience indicator	Text	Free text
index	The calculated resilience index	Decimal	Range 0 to 10
weight	Based on the definition of the weight type a value will be assigned. User will give the rank if required	Integer	Values from 1 to the number of indicators in the same object
real	The real value of the index based on the weight	Decimal	Range 0 to 10
subindicators	List of all sub-indicators that used for this resilience indicator	Array	

4.3.3 Resilience Sub-Indicators / Categories

| Field Name	Field Description	Field Type	Acceptable Values
id	The id of the field	integer	Auto increment number
description	A text description of the sub-indicator	Text	Free Text
source	Indicates the source of the field (i.e. end-user questionnaire, analysis tool)	Integer	Reference to input data
subcategories	This array field contains a list of objects [id, description, value] of all the sub-categories (with indicators) that constitute this indicator. The value of the sub-indicator will be the average among the values within this list.	Array [] (id, description, source, value)	id: the unique id of subcategory description: the description of the indicator in sub-category source: indicates the id of the input (questionnaire or analysis) that the value is calculated value: the index value
value	The value as a result of the analysis tool	Decimal	If subcategories: Value is the averaged of all sub-values Otherwise: Value is calculated based on the input
weight	A field that indicates the weight of the current sub-indicator	Integer	Rank value
real	The real value of index after the usage of weight	Decimal	Index

The following example presents part of the Anticipatory Index and how is calculated for the EU-CIRCLE project. Similar with this, the RAT (D4.5) presents all the considered index that are used for the calculation of the CI Resilience Indicator.

The Overall Resilience Index is a function of the five used indicators (Anticipatory index, Absorptive index, Coping Index, Restorative Index and Adaptive Index). Based on the weights and the real indicator as included in the structure of each indicator the overall resilience index is calculated.

JSON Example:

```json
{
  "id": 1,
  "class": "ANTICIPATION",
  "description": "Anticipatory Index",
  "index": 5.9,
  "indicator": [
    {
      "id": 10,
      "description": "Awarenes of potential hazards",
      "index": 6,
      "weight": 5,
      "real": 0.42,
      "subindicators": [
        {
          "id": 11,
          "source": "ENDUSER",
          "description": "Users awareness of the number of hazards that may threaten an asset",
          "index": 6,
          "weight": 1,
          "real": 6
        }
      ]
    },
    {
      "id": 20,
      "description": "Quality/extent of mitigating features",
      "index": 4.81,
      "weight": 4,
      "real": 0.63,
      "subindicators": [
        {
          "id": 11,
          "description": "Equipment and procedures for hazard mitigation exist",
          "source": "ENDUSER",
          "index": 6,
          "weight": 1,
          "real": 6,
          "subcategories": [
            {
              "id": 22,
              "description": "Procedures are documented",
              "index": 7
            },
            {
              "id": 23,
              "description": "Procedures are regulary revised",
              "index": 5
            }
          ]
        }
      ]
    }
  ],
  "weighType": "RANK"
}
```
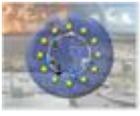
4.3.4   Resilience Levels

The following table presents the different levels that are used for the development of the Resilience Assessment Tool. The final result is the Overall Resilience Index which is a function of the 2nd, 3rd, and 4th level.

Level	Description	Abbreviation
1	Overall resilience index	ORI
2	Capacity Index	
-	Anticipatory capacity resilience index	C-ant
-	Absorptive capacity resilience index	C-abs
-	Coping capacity resilience index	C-cop
-	Restorative capacity resilience index	C-rest
-	Adaptive capacity resilience index	C-adapt
3	Resilience index	R
4	Resilience sub-index	I

4.3.5   Weights Table

The last part of Resilience Data specification is the weights table. As we mentioned in the tables above, the weights are used for the calculation of the several indices at each one of the levels of the Resilience Assessment Tool. The table below, presents the weights that are used in the RANK method.

Rank	Number of Items									
	1	2	3	4	5	6	7	8	9	10
1	1.00	0.67	0.50	0.40	0.33	0.29	0.25	0.22	0.20	0.18
2		0.33	0.33	0.30	0.27	0.24	0.21	0.19	0.18	0.16
3			0.17	0.20	0.20	0.19	0.18	0.17	0.16	0.15
4				0.10	0.13	0.14	0.14	0.14	0.13	0.13
5					0.07	0.10	0.11	0.11	0.11	0.11
6						0.05	0.07	0.08	0.09	0.09
7							0.04	0.06	0.07	0.07
8								0.03	0.04	0.05
9									0.02	0.04
10										0.02
SUM	1	1	1	1	1	1	1	1	1	1

5   Conclusion

Metadata is a set of data able to describe the content and make a data set searchable and then shareable. This deliverable presents guidelines to prepare the metadata for EU-CIRCLE Resilience related data. The purpose of D4.8 is to extend the already proposed (D3.6) approach to create the metadata files for WP4 datasets.

The metadata structure of all the two dataset types that are considered in this work (End-User Questionnaire and Resilience Indicators) is based on a general template (baseline metadata) enhanced with specific fields for each type of data. Finally, this deliverable also presents the EU-CIRCLE data specifications for end-user questionnaire and resilience indicators.

Bibliography

[INSPIRE TG Metadata 2017] Technical Guidance for the implementation of INSPIRE dataset and service metadata based on ISO/TS 19139:2007 (Version 2.0.1)

[INSPIRE TG DS 2011] Technical Guidance for the implementation of INSPIRE Discovery Services (Version 3.1)

[FDGC CS 1998] Metadata Ad Hoc Working Group Federal Geographic Data Committee, Content Standard for Digital Geospatial Metadata

[ISO 19111] EN ISO 19111:2007 Geographic information - Spatial referencing by coordinates (ISO 19111:2007) Part 2 to be published. (https://www.iso.org/standard/41126.html)

[NISO 2014] NISO Press, Understanding Metadata, ISBN: 1-880124-62-9

[ISO 19115] EN ISO 19115:2005, Geographic information – Metadata (ISO 19115:2003) (https://www.iso.org/standard/26020.html)

[ISO 19139] ISO/TS 19139:2007 Geographic information -- Metadata -- XML schema implementation (https://www.iso.org/standard/32557.html)

[ISO 19119] ISO 19119:2016 - Geographic information – Services (https://www.iso.org/standard/59221.html)