# InCLIMATE

## Integrating Climate Resilience in E.U. Higher Education

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# Intellectual Output O4 report

**"Pre-ordinated cognitive structure"**

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Climate change is complex. This complexity mainly emanates from the need to integrate disciplinary knowledge and expertise, both technological and managerial, in an interdisciplinary context to find buildable solutions that improve actual urban resilience strategies. However, training and education in professional silos, and the resultant fragmentation of the academy are significant barriers to integration. This lack of integration is one of the reasons behind the low process towards a low carbon society.

This report presents the methodology, which was adopted to develop a tool and process to activate a knowledge integration and exchange within an interdisciplinary learning environment. It describes and justifies the approach to developing an innovative learning approach founded substantially on a novel application of cognitive maps and meaningful learning activities (MLAs) in exploring sustainable strategies for climate change.

The 1992 Rio Summit has firmly placed the concept of sustainability in the development discourse (Taleghani et al. 2011). It also called for a radical change in education and training to develop and disseminate knowledge about sustainability. Programmes that focus on integrating discrete professional knowledge and tools which facilitate integration have emerged(Schon 1984; Annan-Diab and Molinari 2017). The integrated design paradigm, which involves practitioners, researchers, educators and students, is a recent example (Schauppenlehner-Kloyber and Penker 2015).

The integrated design paradigm requires new skills to achieve a balance between the design process and the final product (Bashier 2014; Alagappam 2015). These skills have been neglected until now (Lawrence 2015). Although this paradigm is widely recognised as relevant (Gano 2015), it has not been integrated into the traditional educational programmes, which are based on the design studio environment (Koch et al. 2002).

There are several issues with the traditional pedagogical approach. This work underlines three issues:

1) it is based on a teacher-centred methodology. Self-directed learning should be at the core of knowledge integration (Kek and Huijser 2011; Galford et al. 2015);

2) the traditional approach is focussed on the studio and the artistic aspects of design (Koch et al. 2002; Bashier 2014);

3) it focuses on high quality outputs, while the new approach focuses on identifying problems (Koch et al. 2002; McAllister 2014).

The integrated design paradigm can deal with these issues as it aims to develop cognitive skills in order to go beyond design as form making (McAllister 2014). As noted by Altomonte (2009), future professionals are required to be more equipped with advanced technical skills in order to deliver sustainability. This is required of today's young practitioners (Torres-Ramírez et al. 2014; Ismail et al. 2017).

These arguments are also valid for exploring climate change and urban resilience issues. Therefore, an innovative approach to education is needed to reconcile creativity and rational decisions in an interdisciplinary learning context.This report conceptualises this approach, presenting the result of the 04 activity: the development of a Pre-Ordinated Cognitive Structure.

***Method and tools to develop the Pre-Ordinated Cognitive Structure***

The cognitive approach, including the associated mapping technique, is the starting point. It emerged in the field of psychology and has brought about innovation in education and training in many other areas (Barrows 1996). There are several approaches to the concept map construction. Our approach is akin to Novak's (Novak 1991), which elaborates thinking process for design. Novak's approach is also well integrated with MLAs (Novak 2011). A brief introduction of this approach is provided to better understand the interactions regarding the integrated design paradigm.

Novak's approach starts with the definition of a focal question (see Figure 1). Concepts that form the answer are ordered in terms of their importance. Phrases which connect the concepts are added and labelled (Zubrinic et al. 2012). Concepts are presented as hierarchies with general concepts at the top, and specific concepts at lower levels (Novak and Cañas 2008). Each concept has a specific role, each relation explains such role, and the sequences of connections define a meaningful discourse related to the focus question. Therefore, the hierarchical organization visualises the thought process through which the focal question has been answered.

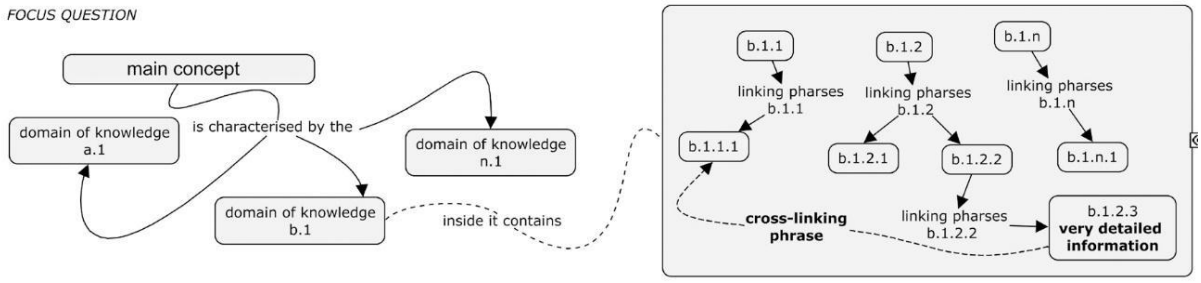


Figure 1. Elements of a Cognitive Map (Sibilla, 2017)

This cognitive structure is considered to be a sound base for developing MLAs in order to elaborate or integrate thought processes. We adopt Jonassen et al.'s (Jonassen et al. 1999; Jonassen and Strobel 2006) MLA classification: observant and manipulative; constructive and reflective; intentional; complex and contextual; collaborative and conversational. (Jonassen et al. 1999) introduce "Intentional activity", which can be related to making sense and valuing each level of the map hierarchy. It can be associated with the subject's competencies. Hence, it refers to the ability to construct a sequence of focal questions which reflect the thought process. This process allows user to visualise pieces of knowledge and thus it facilitates the knowledge exchange and integration.

Our approach proposes the development of a Pre-Ordinated Cognitive Structure (POCS), which has been dedicated to interdisciplinary topics related to climate change and urbane resilience. It has been developed in a computer environment using C-map Tools Software, which supports the elaboration of Novak-style maps.

One of the main features of the POCS is that the information collected will come from research approaches which are normally isolated: inductive and deductive. The former substantially uses scientific papers in order to collect information that comes from advanced studies on different topics concerning climate change. The latter involves the user's knowledge in order to explore how the concept can be integrated.

In addition, the former refers to the activity O4, herein presented. The latter refers to the teaching activities (C1 and C2), which will involve staff and students respectively.

The POCS is an Ontology about climate change; it is not a simple map of it. In fact, it includes domains of knowledge (i.e. that represent relevant focus questions) and proposes a preliminary series of connections among concepts, building meaningful discourses on climate change and urban resilience from multi-perspective views.

The scope is to facilitate orientation, comprehension and modelling of complex themes, developing verbal and non-verbal communication abilities. We adopt a semi-automatic mapping technique (Zubrinic et al. 2012) to ensure greater precision in the identification of concepts and relationships. In this context, the POCS provides information, which has to be contextualized, manipulated, articulated and discussed by users in order to explore interdisciplinary strategies and solutions.

The next section illustrates the procedure to build the POCS in order to explain the connection between the O1, O4, C1 and C2 activities.

### 2.3.1 Create c-maps

The procedure is divided into the following steps:

- Selection of journal papers
- Word-frequency analysis and pattern detection
- Bibliometric map development
- Cognitive map structure definition

#### *Selection of journal papers*

Each partner collected a series of documents and journal papers concerning the topic of climate change and urban resilience with a particular focus on their disciplinary perspectives as part of the O1 activity.

The coordinator of the O4 activity (Oxford Brookes University) asked for a selection of three relevant open access journal paper. These journals had to be open access in order to be included in the POCS, which will be disseminated as an OER. All these papers were uploaded into NVIVO, a software for qualitative analisis.

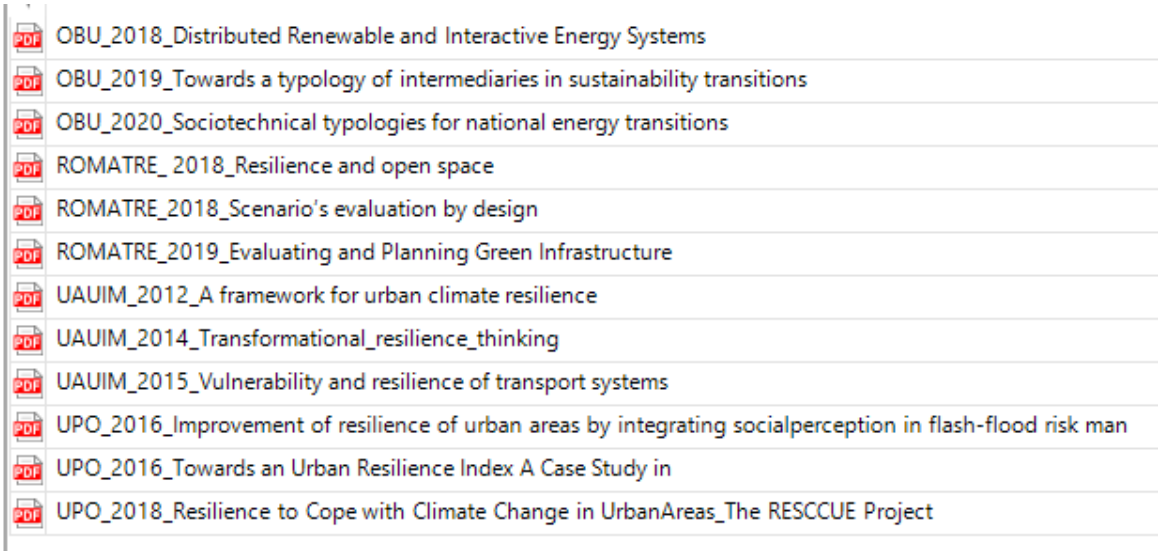


Figure 2. Process of journal paper collection

### *Word-frequency analysis and pattern detection*

A word-frequency analysis was conducted in order to point out the most relevant concepts used in literature. The analysis was conducted at the partner level. As a result, a list of relevant concepts was identified for each partner. The figure below shows an example of the hierarchical visualisation concerning the concepts collected. It shows how some concepts are common between different disciplines (i.e. resilience). At the same time, It points out what concepts characterise a specific domain of knowledge.

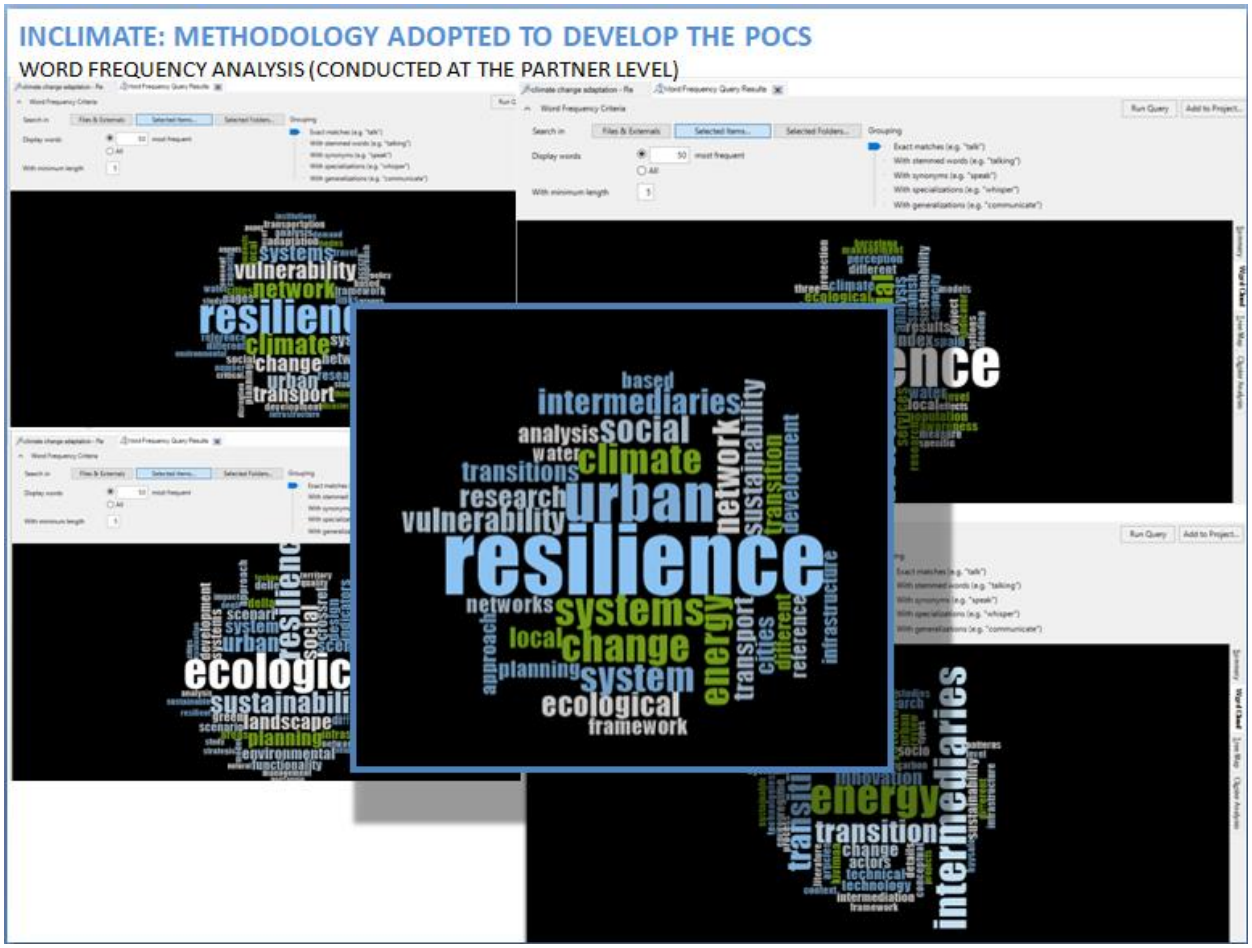


Figure 3. Word-frequency analysis result

However, the word-frequency analysis is not sufficient to explain how the concept was used in literature. In order to resolve this lack, a pattern analysis was carried out. The pattern analysis is very useful because, on the one hand, it allows us to contextualise concepts; on the other hand, it allows an integration among the disciplinary perspective. Indeed the pattern analysis starts identifying relevant concepts. As pointed out above, this was done at the level of the partner. For example, the concept “Climate Change Adaptation) emerged as one of the most relevant concepts for all partners. Through the pattern analysis is possible to identify the context concerning its use. Firstly, the analysis pointed out what sources used this concept and then it identifies a specific relevant contextualisation (figure below).

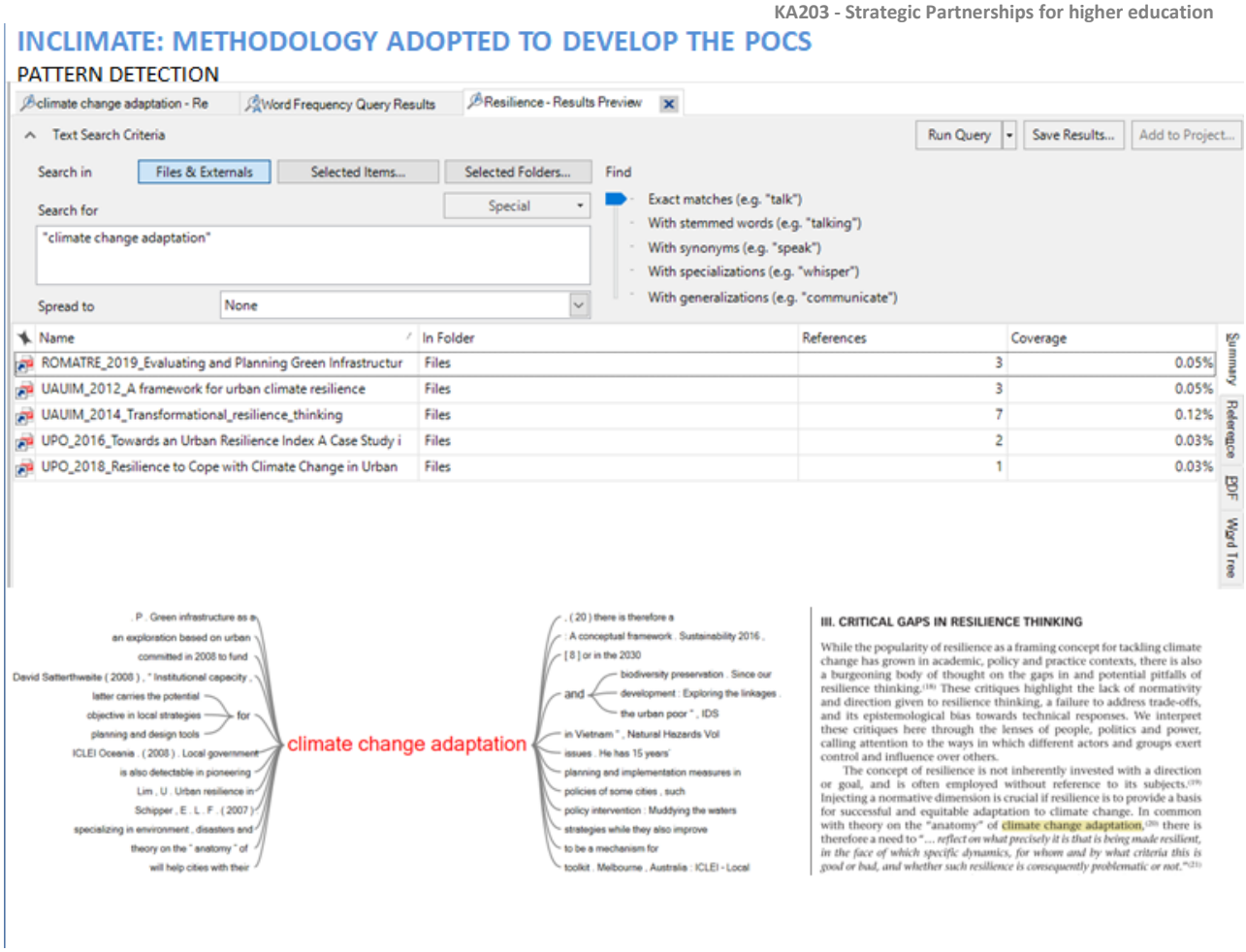


Figure 4. Word pattern detection

### *Bibliometric map development*

As a result of the prior step, a set of relevant concepts were identified. However, these concepts refer to a very restricted number of journals. In addition, it was not possible to visualise the connections of these concepts within a broader vision. In order to resolve this gap, a bibliometric analysis was carried out. This analysis was developed as follows. For each partner, a combination of relevant concepts was used to run a search adopting a WoS platform.

- Eco-innovations, Forest Economics, Forest Ecosystems
- Renewable Energy, Energy Efficiency, Environmental Management
- Built Environment, Energy system, Environmental Design
- Adaptative Capacity, Social Vulnerability, Sustainable Indicators
- Urban Design, Urban Management, Urban Policies
- Landscape Quality, Spatial Plannign, Territorial Resources

As a result, 6 bibliometric maps were developed. Then this search was unified, delivering a unitary bibliometric map.

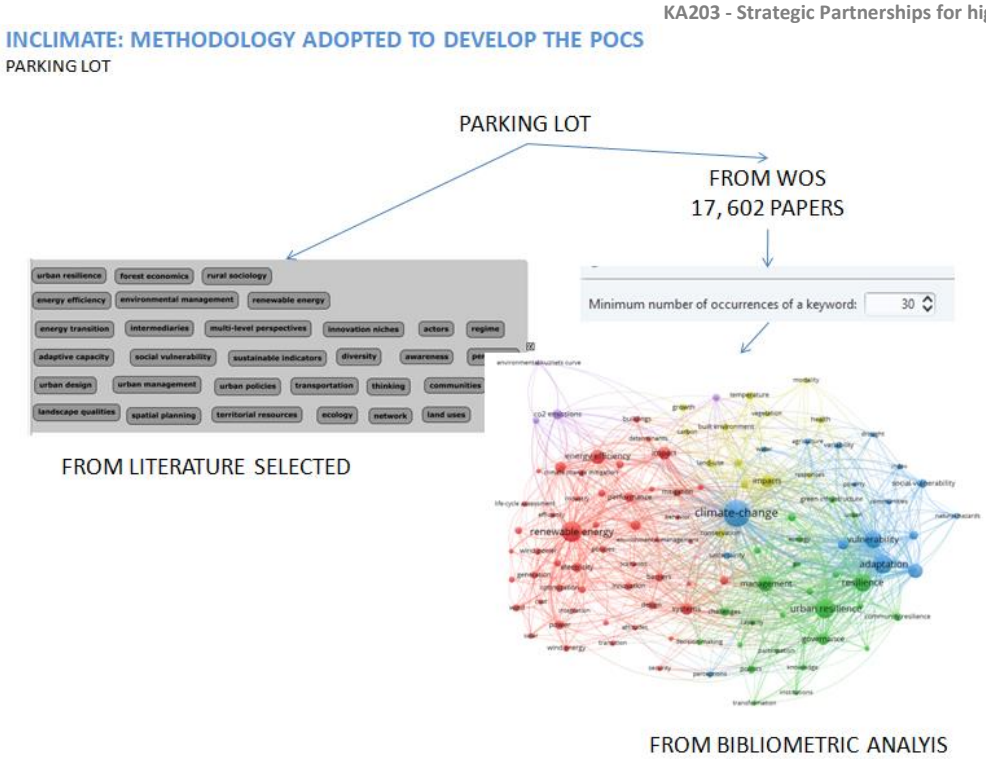


Figure 5. Bibliometric map development

The bibliometric map acts as a visual "parking lot" within the POCS. The parking lot is a set of concepts, which are not connected to each other, but they can reduce the effort of users to remember or to produce connections. POCS is developed in a computer environment so that multimedia file can add to the map.

By doing so, all relevant information was collected in order to elaborate the POCS. The POCS is a concept map characterised by the components of the novakian map.

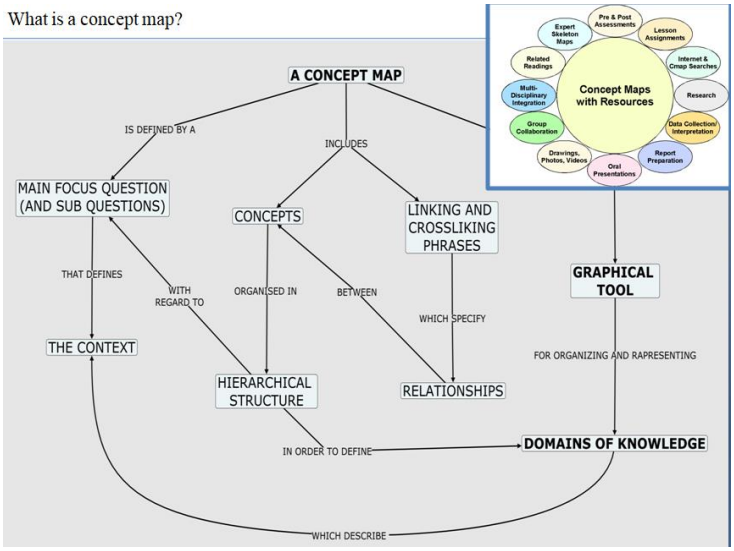


Figure 5. Generic structure of conceptual map in Novakian style.

***The Pre-Ordinated Cognitive Structure***

The POCS proposes the following focus question:

- What concepts characterise climate change and urban resilience issues from your point of your

The first focus question (FQ) must be generic in order to be understandable by all disciplines and level of prior knowledge. In addition, the FQ points out that the map seeks to promote the user's perspective. The organisation of the POCS is simple. The Climate Change concept is located at the top of the map; it is the main topic. Then, taking into account the information collected during the prior phase, the POCS is articulated in two ramifications. On the right, the POCS lists some concept concerning the consequence of climate change. On the left, it lists three main concepts, which refer to strategies to solve the issue. The image below, which represents the POCS is a static visualisation. When the POCS is used with the support of Cmap-Tools, additional information can be acquired by the user.

Each component with the symbol (*) has additional information. The icon at the bottom of the concepts indicated the link to additional external documents (e.g. maps, journal papers, web-site among other). By doing so, the POCS is delivered as an OER ready to be adapted and implemented in relation to the user's scopes and the learning environment where it will be used.

The map presents some essential connections useful to activate the user's prior knowledge through the application of the MLAs.

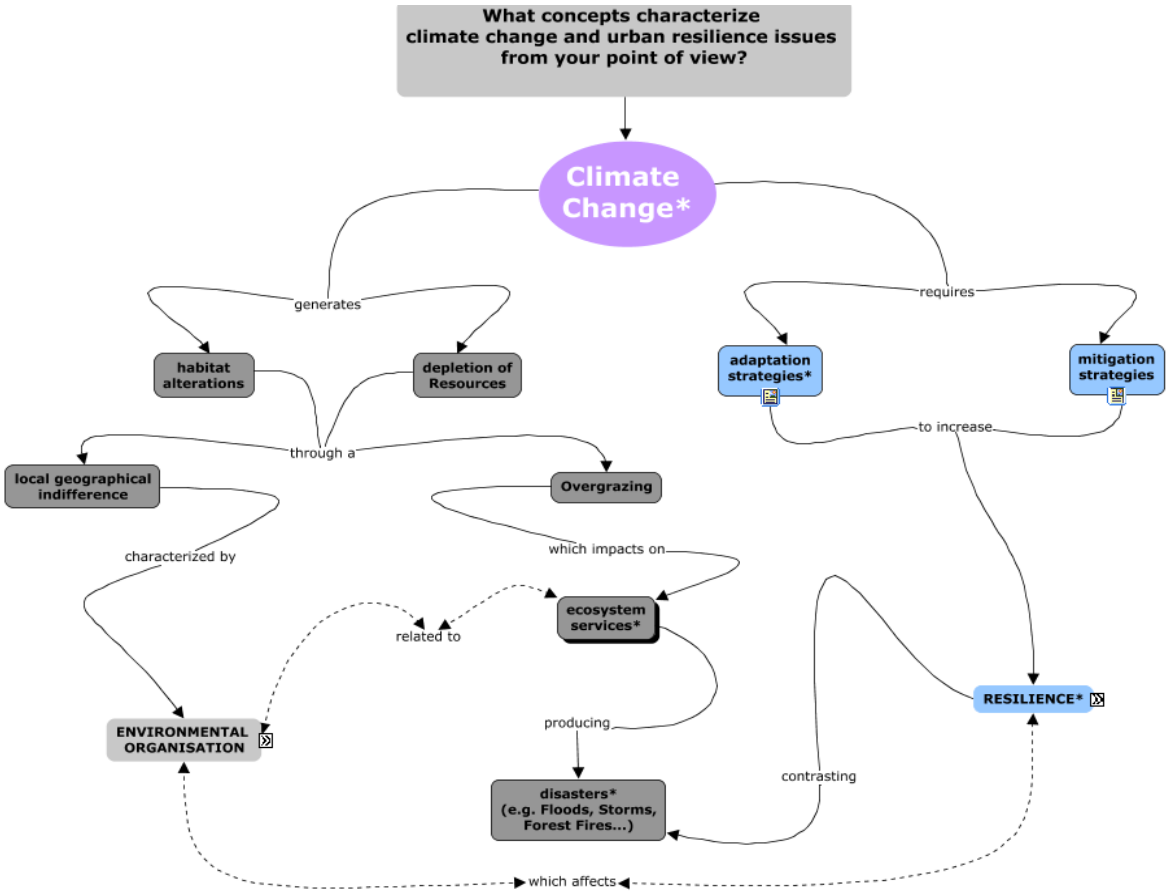


Figure 6. The Pre-Ordinated Cognitive Structure.

Furthermore, the map takes into account the domains which represents the background of the member of the InClimate consortium: Natural Environment and Built Environment. This distinction is replicated

both on the right and left side of the map. This articulation suggests the user to work within the domain, which better characterises his/her background.

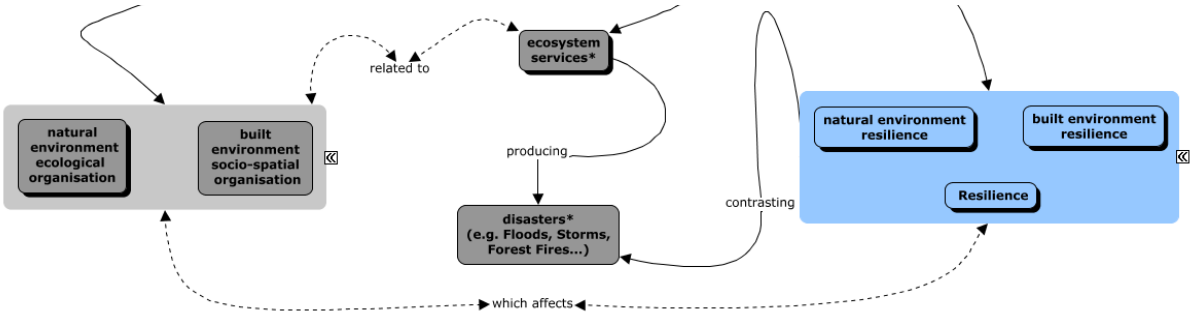


Figure 7. Natural and built environment domains stressed by the POCS

***The Pre-Ordinated Cognitive Structure on Cmap-Tools***

As anticipated the POCS has been disseminated as an OER through the public servers of Cmap-Tools. Here, the istruction to find and use the map are provided.

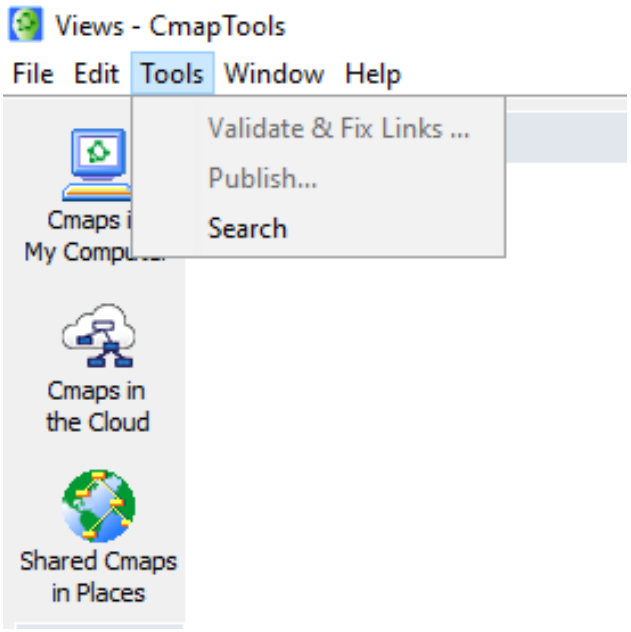


Figure 8a. 1) Open cmap and go on TOOLS - SEARCH

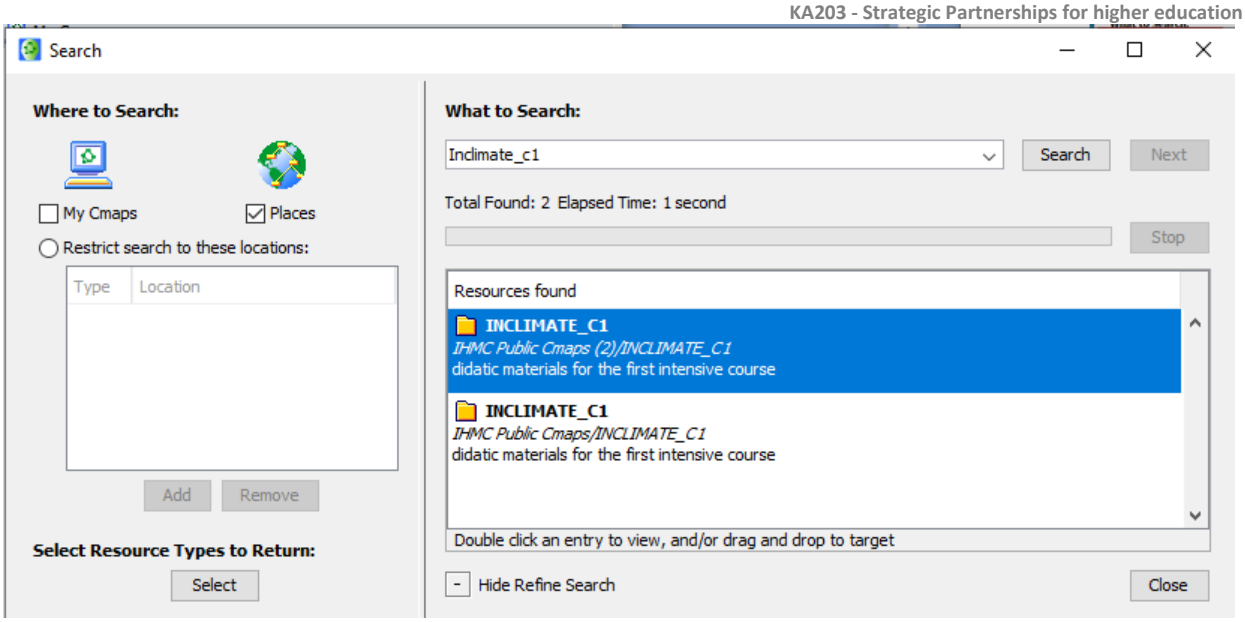


Figure 8b. 2) Clink on Refine Search and select Place. Then write Inclimate_c1. Select the folder IHMC Public Cmaps(2) (in blue).

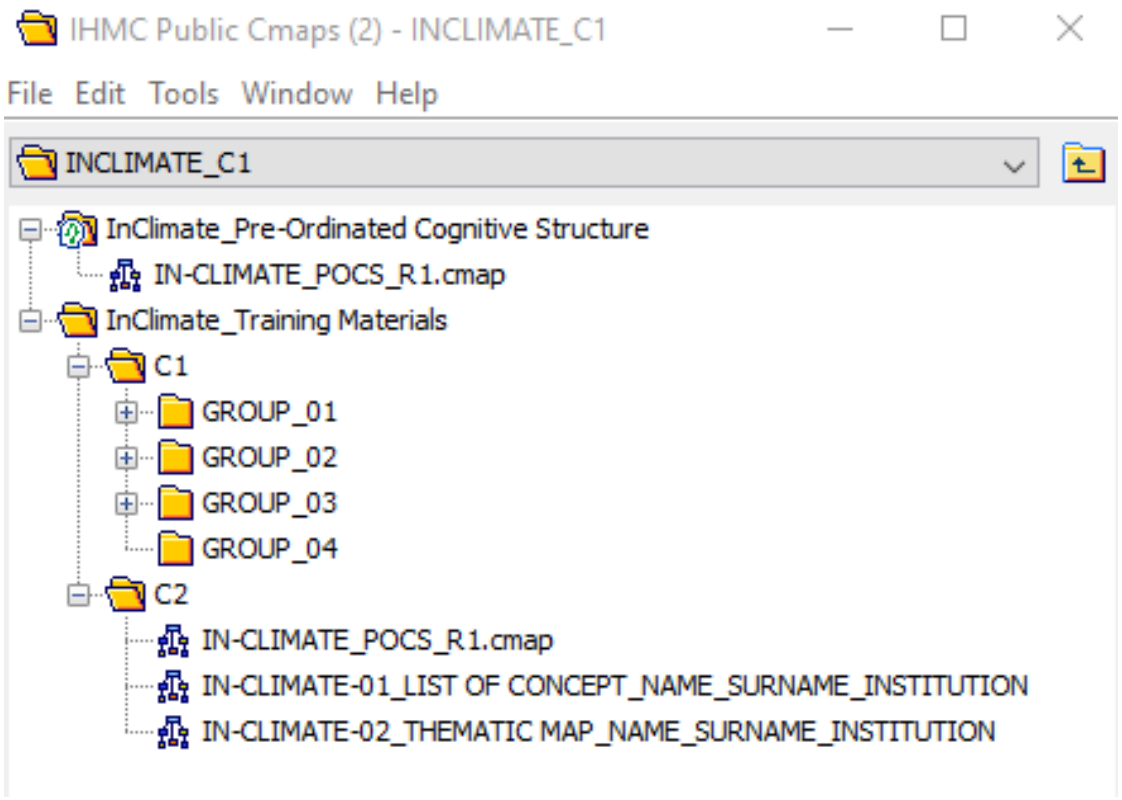


Figure 8c. 3) Download the file you need.

### 2.3.2 Create Thematic maps

Thematic maps (TMs) are those point out the user's perspective related to the topic proposed by the POCS. At the first stage, TMs will provide an answer to the same FQ proposed by the POCS. Subsequently, TM will be able to deal with other more detailed issues. This depends on the learning environment where the POCS will be used.

Therefore, TMs is a tool to improve the information collected in the POCS Inclimate projects proposes two learning moments where TMs will de developed: the first and second intensive course dedicated to staff and students, respectively.

Figure 9 shows how to develop and implement the pre-ordinated cognitive structure (POCS) as planned into the proposal.

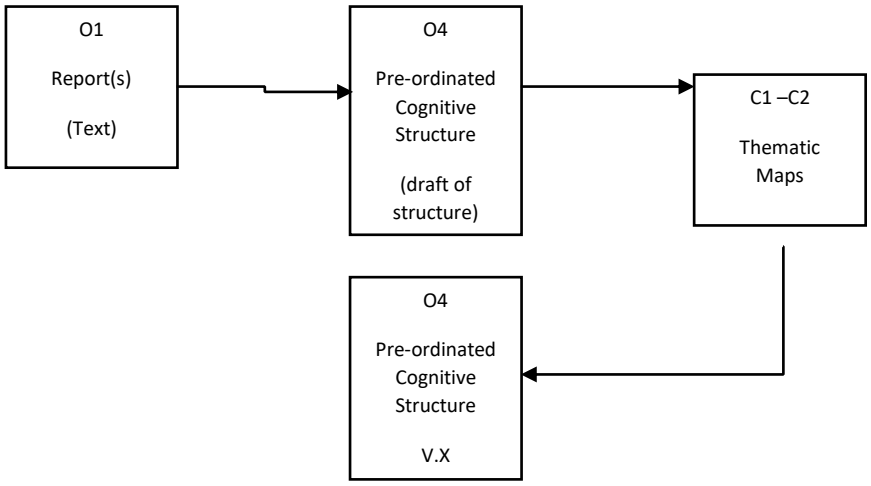


Figure 9. Process to develop and implement the pre-ordinated cognitive structure (POCS)

Figure 10 presents the preliminary structure of a TM, which answer a generic focus question (the same as the POCS). This template is provided as learning material, and it will be adopted during the C1 and C2 course.

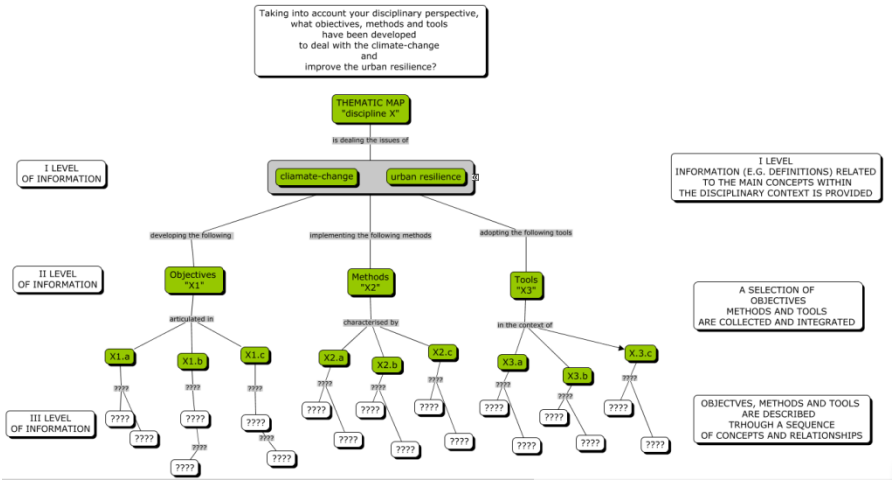


Figure 10. Thematic Map template.

Each partner will be engaged in a process to personalise this preliminary structure, during the C1/2 activities In addition, the TMs will be discussed during a brainstorming phase.

Please, note that it will not be necessary to cover all the disciplinary implications related to Climate-Change and Urban Resilience, but each partner will be called to point out some relevant aspects, with a particular focus on their expertise and background. This is because the map will be used to promote interdisciplinary knowledge exchange and integration. For this reason, TMs can be considered as "incomplete" and ready to be personalised by the user.

In order to elaborate the TMs a set of three excersise has been planned. They are articulated as follows:

- Phase 1-Individual *The Participant has to elaborate a LIST OF CONCEPTS that characterizes his/her prior knowledge concerning the FOCUS QUESTION*
- Phase 2-Individual *The Participant has to transform the LIST OF CONCEPTS into a THEMATIC MAP*
- Phase 3-Collaborative *Participants have to integrate their (THEMATIC MAP) developing/customising the information collected into the POCS*

The sequence of this exercise can be personalised.

TMs are relevant to integrating information into the POCS through a cogntive process rather than simply collecting information. In addition, TMs allow users to visualise specific concepts and connections, which allows other users to interact within the cognitive framework proposed. Phase three (Collaborative) is dedicated to this process of knowledge integration and exchange. Figure 11 shows how this process works in association with the Meaningful Learning Activities.

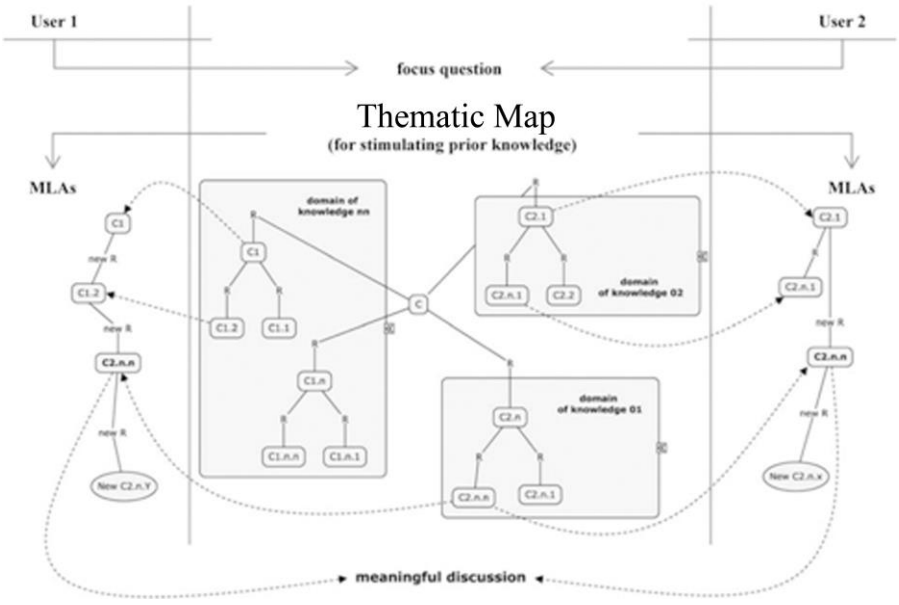


Figure 11. Thematic Map – Knowledge integration and exchange process. Each user proposes a set of concept and connection to elaborate his/her TM. The results are compared with other TMs. By doing so, Users are engaged in collaborative TM production, trying to point out common concepts and/or to discuss the disciplinary differences.

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