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Table of Contents

Index of Figures

1. Management summary

1.1. Purpose of this document

Purpose of this document is the description of the TaToo Validation Scenario "Climate Change Twin Regions – Discovery Platform (Climate Twins)". The Climate Twins application developed by AIT (Climate Twins Viewer, http://foresight.ait.ac.at/projects/climatetwins/) enables the comparison of present and future climate conditions in European regions.

Climate Twins is based on the idea that an impression of the future climate of a specific region can be received from the present climate in other regions. Climate modelling allows projections of climate change at a global but also at lower spatial levels. These simulations show that climate conditions, which are currently typical for particular regions, will eventually shift towards other latitudes. This means that the future climate conditions in a particular region can be expected to be similar to those prevalent in other regions at present. Finding such comparable regions is the goal of Climate Twins. This is done by comparing simulation data of the climate parameters 'temperature' and 'precipitation' in the future with the present climate data. Those regions where future and present climate parameters are similar are then called "climate twin regions".

The objective of Climate Twins is therefore to let people and institutions know what the climate in their respective regions will look like (according to climate projection models) in the future by showing other regions which have similar climate conditions today. Looking at these "climate twin regions" makes it easier for them to get a vivid impression of the future climate in their respective regions since they can visualize what is already out there. Moreover, this can be achieved without a need for any scientific knowledge.

When the users invoke the Climate Twins Web portal, they can choose a certain place in Europe, whose future climate conditions they are interested in. We call such a place a "Point of Interest" (POI). Underlying the map of Europe the Climate Twins application holds the future climate indicators as a background layer. The values of the climate parameters at the selected POI and for the defined period in the future are then compared with the current climate values in all the rest of Europe on a cell by cell basis. The current climate grid cells which show a certain similarity with the future climate conditions at the POI are then identified as "climate twin regions". In the map showing the results, the user can easily see which places in Europe have similar current climate conditions to those projected, future climate conditions at the POI. The darker the colour, the more similar the respective regions are to the the chosen POI.

The Climate Twins application is fully operational and can be freely accessed. Nevertheless, there is a room for improving its functionalities and usability as well as its discoverability. Having this in mind we have integrated the TaToo Public Services into the application, which have complemented it by support for the following four Use Cases:

- Make it easier for interested people from different fields of science, politics, public authorities and business (i.e. people who are not climatologists), who are searching the

Web for suitable resources dealing with the future climate in their regions, to find the Climate Twins application.

- Give the users a possibility to evaluate the Climate Twins application and its community-added resources for other users (regarding type, scope and quality of the content) which, in turn, enables the Climate Twins resource provider to further develop the model according to the final users' needs. Furthermore, it helps the users to distinguish valuable from weak resources added by other users.
- Give the users the possibility to find additional information beyond the Climate Twins data on their specific regions of interest.
- Give the users the possibility to add some additional information by themselves for the sake of other users.

1.2. Intended audience

The targeted readers of this deliverable are all people interested in Climate Twins, the used prediction model and the application. It is also a valuable source of information for those interested in the use of the TaToo Public Services within the Climate Twins application.

2. Abbreviations, acronyms and glossary

2.1. Abbreviations and acronyms

A1B	IPCC scenario, The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. A1B depicts a balance across all (fossil and non-fossil) energy sources in the future.
CLM	Climate Limited-area Modelling
COSMO-CLM	COnsortium for SMall scale MOdelling – Climate Local Model
ECHAM5	Climate model developed from the European Centre for Medium-Range Weather Forecasts (ECMWF, Reading) operational forecast model cycle 36 (1989) (first part of the name: EC) and a comprehensive parameterisation package developed at Hamburg (abbreviation HAM) (Version 5).
GCM	Global climate model
GUI	Graphical User Interface
IPCC	Intergovernmental Panel on Climate Change
MPIOM	Max-Planck-Institute Ocean Model
POI	Point of Interest
UC	Use Case
URI	Uniform Resource Identifier
URL	Uniform Resource Locator

2.2. Glossary

Climate Twins
Climate Twins is a model which shall demonstrate the possible future changes of climate conditions at a regional level. This is done by indicating all regions which have climate conditions today that are similar to the future projected conditions in a certain region of interest. Similarity is based on the climate parameters 'temperature' and 'precipitation'. The projection of these climate parameters is based on the COnsortium for SMall scale MOdelling – Climate Local Model (COSMO-CLM). Climate Twins is freely accessible via the Web: http://foresight.ait.ac.at/projects/climatetwins/.

COnsortium for SMall scale MOdelling – Climate Local Model (COSMO-CLM)
COSMO-CLM is a local climate projection model with a 18x18 km resolution. It has been developed by the Consortium for Small scale Modelling (http://www.cosmo-model.org/). Its version 2.4.11 provides the temperature and precipitation data for Climate Twins.

Meta-Information (RM-OA, 2007)
Descriptive information about resources in the universe of discourse. Its structure is given by a meta-information model depending on a particular purpose. Note: A resource by itself does not necessarily need meta-information. The need for meta-information arises from additional tasks or a particular purpose (like catalogue organisation), where many different resources (services and data objects) must be handled by common methods and therefore have to have/get common attributes and descriptions (like a location or the classification of a book in a library).

Tagging
Adding Meta-Information to a resource.

TaToo Tool
A front-end component generally but not necessarily with a graphical user interface that allows or supports interaction with a human user. It resides on the Presentation Tier and acts as a client for the TaToo Public Services. Examples: the TaToo Portal, a client API library, a TaToo Toolbar.

TaToo Public Service
Service exposing the functionality of the TaToo System through a public, well-defined and formally specified interface. Resides on the Service Tier.

Use Case
Use Cases are the specific forms of using TaToo Tools by a certain Validation Scenario; see Validation Scenario.

Validation Scenario
Scenarios are used to validate the usability of TaToo's developments.

3. Description of the Validation Scenario "Climate Twins"

"Climate Change Twin Regions – Discovery Platform" is one of three Validation Scenarios of the TaToo project. It is based on a regional climate simulation application called "Climate Twins" which has been developed by the AIT Foresight & Policy Development Department and which is freely accessible on the Web. In this chapter we describe the objectives and features of Climate Twins and how it can be used. After that, in chapter 4, we present the TaToo Use Cases of Climate Twins.

3.1. The idea of Climate Twins

Climate Twins is based on the idea that an impression of the future climate of a specific region can be received from the present climate in other regions. In a world experiencing global warming the climate of regions in the North will become similar to what can be encountered today in more southern regions. Climate modelling allows projections of climate change at a global but also at lower spatial levels. These simulations show that climate conditions, which are currently typical for particular regions, will eventually shift towards other latitudes. This means that the future climate conditions in a particular region can be expected to be similar to those prevalent in other regions at present. Finding such comparable regions is the goal of Climate Twins. This is done by comparing simulation data of the climate parameters 'temperature' and 'precipitation' in the future with the present climate data. Those regions where future and present climate parameters are similar are then called "climate twin regions".

The objective of Climate Twins is therefore to let people and institutions know what the climate in their respective regions will look like (according to climate projection models) in the future by showing other regions which have similar climate conditions today. If someone is interested in the temperature, the precipitation or both in his or her region sometime from now, Climate Twins takes the projected data for this region, compares them with recent data in Europe, and shows the regions with similar climate conditions today. Looking only at the projected climate data is rather abstract. But looking at real "climate twin regions" makes it easier for them to get a vivid impression of the future climate in their respective regions since they can visualize what is already out there. Moreover, this can be achieved without a need for any scientific knowledge.

This information is provided by a freely accessible Climate Twins Web application via an easy-to-use Webbrowser-Interface (http://foresight.ait.ac.at/projects/climatetwins/). It will be described in the remainder of chapter 3.

It is the aim of the team in the AIT Foresight & Policy Development Department, which has developed the Climate Twins application, to achieve public awareness and thorough understanding about the predicted climate changes and their implications for future generations. For this purpose we need to identify best ways to communicate the output of scientific models to the public which would be both scientifically sound and easily understandable. Climate Twins tries to address this challenge via an intuitively usable Web application covering the whole of Europe. A person who is interested in information about expected future climate conditions in

his/her hometown or village, gets the opportunity to do so by simply clicking on a grid cell that fits to this specific location in an interactive map and receives as a result a second map where grid cells showing similar current climate conditions are indicated. In this way scientific output can be communicated easily to the public.

3.2. The underlying model of Climate Twins

Before describing the Climate Twins application, it is necessary to give a brief explanation of the modelling background. Future climate simulations show significant deviations from current climate during the coming decades (e. g. regarding temperature, precipitation, humidity, snow cover or extreme weather events that affect environment and society). Scientists working with complex climate models deliver sophisticated reports and large data sets of model outputs that usually can only be understood by members of the climate research community with pre-existing knowledge necessary to understand such derived data.

Climate models simulate the future climate – like weather prediction models – iteratively. For each time step the model delivers data on the atmospheric state as a 3-dimensional grid with a number of vertical layers. The atmospheric processes are calculated in short time steps for each of the grid cells and are quantified through variables like atmospheric pressure, temperature, humidity, cloud cover, (near surface) precipitation, wind velocity etc., finally compiled to hourly mean and sum values. Due to computational limits, global simulation models deliver results in the best case with a grid resolution of 1°, which corresponds in mid-latitudes to approximately 120x120 km grid spacing.

Due to the coarse resolution of global climate models (GCMs), regional terrain effects in mountain areas remain to a large extent unconsidered. To explain regional effects, regional-scale climate scenarios are necessary to achieve regional scale results for sub-domains of the globe (e.g. related to Europe). The test data and the data implemented in the Climate Twins application have been calculated with the German COSMO-CLM (COnsortium for Small-scale MOdeling – Climate Local Model) model version 2.4.11. The horizontal resolution of the COSMO-CLM is 0.165°, or app. 18 km on a rotated grid. The pan-European data from 1960 to 2100 were calculated, using the coupled atmosphere-ocean global climate model ECHAM5/MPIOM as driving force. The climate of the 20th century was modelled according to the IPCC AR4 20C3M climate reconstruction experiments, the 21st century relays on the A1B IPCC scenario, which is based on moderate demographical, economical and ecological assumptions. The GCM ECHAM5/MPIOM and its components were developed by the Max Planck Institute for Meteorology in Hamburg.

The climate models mentioned above are very well documented. Further details of COSMO-CLM can be found at http://www.cosmo-model.org/. Further information on the global climate models ECHAM5 and MPIOM is available at http://www.mpimet.mpg.de/en/wissenschaft/modelle/echam/echam5.html and http://www.mpimet.mpg.de/en/wissenschaft/modelle/mpiom.html, respectively.

3.3. Calculating similarity of climate conditions in Climate Twins

Climate Twins uses projected climate parameters as input data. The input data come from the climate models described above (see chapter 3.2). The service provided by Climate Twins is the calculation of similarity values for regional climate profiles. The comparison of regional climate conditions in Climate Twins is based on two climate variables: temperature and precipitation. The output of Climate Twins is a graphical representation of similarity values regarding these climate parameters. The spatial resolution of all data is always a grid of regular 18x18 km cells.

The input data of the Climate Twins application are values of the two climate variables 'temperature' and 'precipitation', which are obtained through a specific climate projection model:

- Input variable '**Temperature**': Daily mean temperature (air temperature at surface level) in degree Celsius at a spatial resolution of 18x18 km, source: CLM 1961-2100.
- Input variable '**Precipitation**': Daily total precipitation (in mm per m^2) at a spatial resolution of 18x18 km, source: CLM 1961-2100.

The output of the Climate Twins application are similarity measures of climate conditions at a 18x18 km spatial scale based on these two climate parameters. The users of the Climate Twins application access the output of Climate Twins – a graphical representation of similarity at grid cell-level. The user can select one out of two different similarity measures (Ungar, 2010):

- **Proportional similarity**: Value of similarity for temperature and/or precipitation for all grid cells in comparison with the cell of interest based on the proportional similarity measure for a certain period of time.
- **Hellinger coefficient**: Value of similarity for temperature and/or precipitation for all grid cells in comparison with the cell of interest based on the Hellinger coefficient measure for a certain period of time.

The Climate Twins user locates the grid cell he/she is interested in, "grid cell of interest", also called "point of interest" (POI), and selects the time periods to be compared: the future time period for the grid cell of interest and the reference time period for all other grid cells. Available time periods are decades between 1961 and 2100. Further choices available to the user concern the climate parameters (temperature or precipitation or both), the similarity measures (proportional similarity or Hellinger coefficient), the time of the year to be compared (the whole year or one of the four seasons), the weighting of the climate parameters (if both are selected) and the similarity measure thresholds (a compared grid cell has to pass to be further considered in the comparison).

Concerning the calculation of the seasonal similarity of the grid cell of interest with all other grid cells the calculation differs between the two available similarity measures. The respective formulas are

$$Proportional\ similarity = \sum_{i=1}^{C} min\,(f_{Ui}, f_{Vi})$$

$$Hellinger\ coefficient = \sum_{i=1}^{C} f_{Ui} * f_{Vi}$$

where f is the relative frequency, U indicates the grid cell of interest, V the other grid cells, C is a frequency category (of predetermined ranges of temperature and precipitation) and i is the category's index.

In the case of both similarity measures the values of similarity can range between 0 and 1, where 0 means "not similar at all", 1 means "perfectly identical".

3.4. The Climate Twins interface

How can a user interact with the Climate Twins application? The current version of the Climate Twins user interface can be accessed via http://foresight.ait.ac.at/projects/climatetwins/. The following ***Figure 1*** shows an example of a Climate Twins search result. The functionality of the Climate Twins user interface (in its initial version, before the integration of the TaToo Public Services) will be explained according to this example.

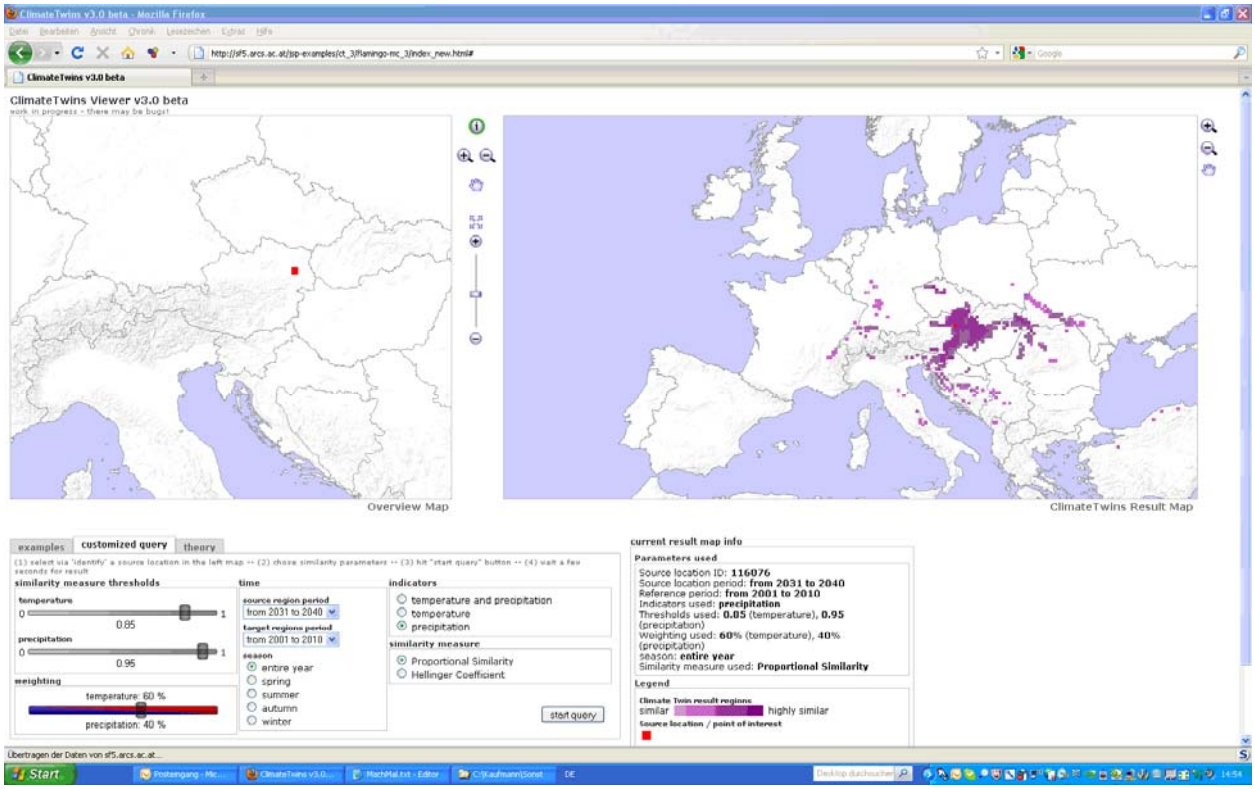

Figure 1: Climate Twins interface with an example of a query

When the user invokes the Climate Twins Web portal, he/she sees two maps of Europe. On the left hand side map (the so-called "Overview Map") he/she can choose a certain POI. In the example shown in ***Figure 1*** the POI (marked red) is an area close to Vienna, Austria.

After having selected the place of interest (the POI), the user has to make several specifications in the Tab "customized query":

- Indicators: Selection of the climate parameter(s) used to calculate similarity of climate conditions: temperature only, precipitation only, or both. In this example the user selects 'precipitation' only.
- Time: Definition of the future time period for which the climate parameters at the POI (called "source region") have been projected as well as the period for all other parts of Europe (called "target regions"). In this example the user defines the period from 2031 until 2040 for his/her selected POI and the comparison period from 2001 until 2010 for the other places. This means that in this example the climate two decades from now at the POI is going to be compared with the most recent climate conditions in the other parts of Europe.
- Similarity measure: Choice between the two similarity measures "proportional similarity" and "Hellinger coefficient". In this example the user chooses the proportional similarity measure.
- Season: Choice between an annual climate profile or a seasonal one. If a seasonal profile is preferred, the user has to define which season. In this example the user selects the entire year.
- Similarity measure thresholds. Definition of the lower limit of what can be accepted as "similar" in order to avoid to get too many areas with similar climate conditions. In this example only the threshold for 'precipitation' matters.
- Weighting: If the comparison is based on both climate parameters, the weighting between temperature and precipitation has to be defined. In this example this selection is meaningless, because only indicator, 'precipitation', has been chosen.

After having made all choices, the user submits the query. Underlying the map of Europe the Climate Twins application holds the future climate indicators as a background layer. The values of the climate parameters at the selected POI and for the defined period in the future are then compared with the current climate values in all the rest of Europe on a cell by cell basis. The current climate grid cells that show a certain similarity with the future climate conditions at the POI are then identified as "climate twin regions" and are displayed in the map on the right hand side.

In the "Climate Twins Result Map" the user can easily see which places in Europe show similar climate conditions today like they are projected to be in the future at the POI. The darker the colour, the more similar the respective region's current climate condition is to the future climate in the chosen POI.

In the example considered here (see ***Figure 1***) the comparison was done based on the indicator 'precipitation' only (the weighting between the two climate parameters is therefore meaningless in this case). The results show that the future amount of precipitation at the POI

(which is located at the eastern edge of the Alps) in the period 2031-2040 is expected to become similar to the amount of precipitation prevalent today farther in the East and South of Europe.

Besides the Tab "customized query" there are two further Tabs "examples" and "theory" where the user can find examples showing how to use the application and some information on the underlying theory, i.e. an explanation how similarity is calculated in Climate Twins.

4. Use Cases

The Climate Twins application is fully operational and can be freely accessed. Nevertheless, there is a room for improving its functionality and usability as well as its discoverability. Having this in mind we have integrated the TaToo Public Services into the application, which have complemented it by support for the following four Use Cases (UC 1 - 4):

- UC 1 – Discovery of Climate Twins: Make it easier for interested people from different fields of science, politics, public authorities and business (i.e. people who are not climatologists), who are searching the Web for suitable resources dealing with the future climate in their regions, to find the Climate Twins application.
- UC 2 – Tagging of Climate Twins and its community-added resources: Give the users a possibility to evaluate the Climate Twins application and its community-added resources for other users (regarding type, scope and quality of the content) which, in turn, enables the Climate Twins resource provider to further develop the model according to the final users' needs. Furthermore, it helps the users to distinguish valuable from weak resources added by other users.
- UC 3 – Find additional information on a particular Climate Twin region: Give the users the possibility to find additional information beyond the Climate Twins data on their specific regions of interest.
- UC 4 – Add additional information on a particular Climate Twin region: Give the users the possibility to add some additional information by themselves for the sake of other users.

4.1. Discovery of Climate Twins

Regarding Use Case 1 the benefit of TaToo comes from raising the chance that interested people from different fields of science, from politics, public authorities and business (i.e. people who are not climatologists), who are searching the Web for suitable resources dealing with the future climate in their regions, will find the Climate Twins application. The beneficiary is the provider of the Climate Twins resource.

In the Climate Twins Validation Scenario, the targeted audience comprises a wide range of people who differ significantly with regard to their type and depth of knowledge, their interests, their perspectives and the terminology and phraseology they use. For example, a tourism manager might search the "future climate in (his/her) region". In case of someone working in a winter sports region, the search phrase might concern more specifically the "future snowfall in (his/her) region". If the person is more familiar with the underlying climate processes, he/she

might search for details of the "future temperature and precipitation profiles in (his/her) region". A biologist might be interested to find information on "map data on habitat climate for (a certain) animal". A person responsible for disaster prevention in a municipality might be looking for the "risk of flooding in (his/her) region in the next decade".

TaToo provides the possibility to search semantically for such sets of terms and phrases. Supporting the searches of people with very different professional backgrounds with semantics should be able to direct their searches for issues related to the future climate in particular regions also to the Climate Twins application (besides other resources). Climate Twins can then be found without having to formulate searches in a single domain-specific way.

The Use Case *Discovery of Climate Twins* is outlined in the following flow chart (see ***Figure 2***):

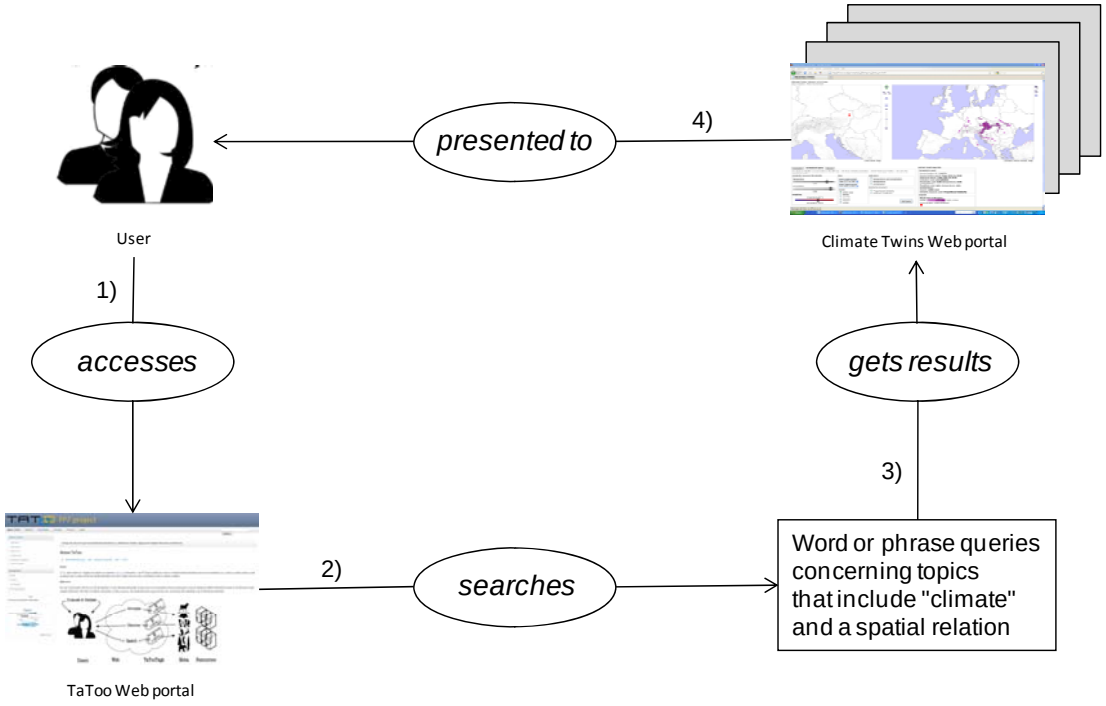

Figure 2: Flow chart UC 1 – Discovery of Climate Twins

While using the TaToo Web portal (step 1) a person searches there for a specific term, set of terms or phrase related to climate conditions or their change in the future at a certain region or place (step 2). TaToo processes this search and returns suitable results (step 3). Supported by semantic search, the user will find a link pointing to the Climate Twins Web portal in the list of results (step 4). Based on this list the user will luckily have a look at the Climate Twins application.

People searching the Web for information about the future climate of a specific region can do this either by turning to well-known, general-purpose search tools, or by using more focussed services which collect and provide specific resources on climate-related issues (e.g. climate models, climate projections, climate mitigation or adaptation measures, climate-related policies

etc.). Usually, the search is done by entering keywords or selecting thematic categories, and it is limited to syntactic search. Semantic search, on the contrary, will enable the search of full phrases as mentioned above as well as consider the meaning (semantic) of it. This will allow users to formulate searches in ways which are much closer to their respective professional backgrounds and languages. As a consequence, semantic search by TaToo can be expected to increase the probability that Climate Twins will be found by more people than with syntactic search only.

4.2. Tagging of Climate Twins and its community-added resources

The benefit of TaToo regarding Use Case 2 is the enrichment of the Climate Twins application through Meta-Information added by users. Giving the users a possibility to evaluate the Climate Twins application and its community-added resources regarding usefulness of the one and quality of the others enables the Climate Twins resource provider to further develop the model according to the final users' needs, and helps other users to distinguish valuable from weak resources. Users provide their evaluation by placing tags on the Climate Twins application and/or on geo-located additional resources added by other users (see Use Case 4, section 4.4). These tags are visible for all users who access the Climate Twins application or specific geo-located additional resources. The beneficiaries are both the Climate Twins resource provider and the users of the Climate Twins application.

This Use Case refers to the possibility of a user to evaluate the Climate Twins application itself and the resources added by other users. ***Figure 3*** shows the flow chart of this Use Case.

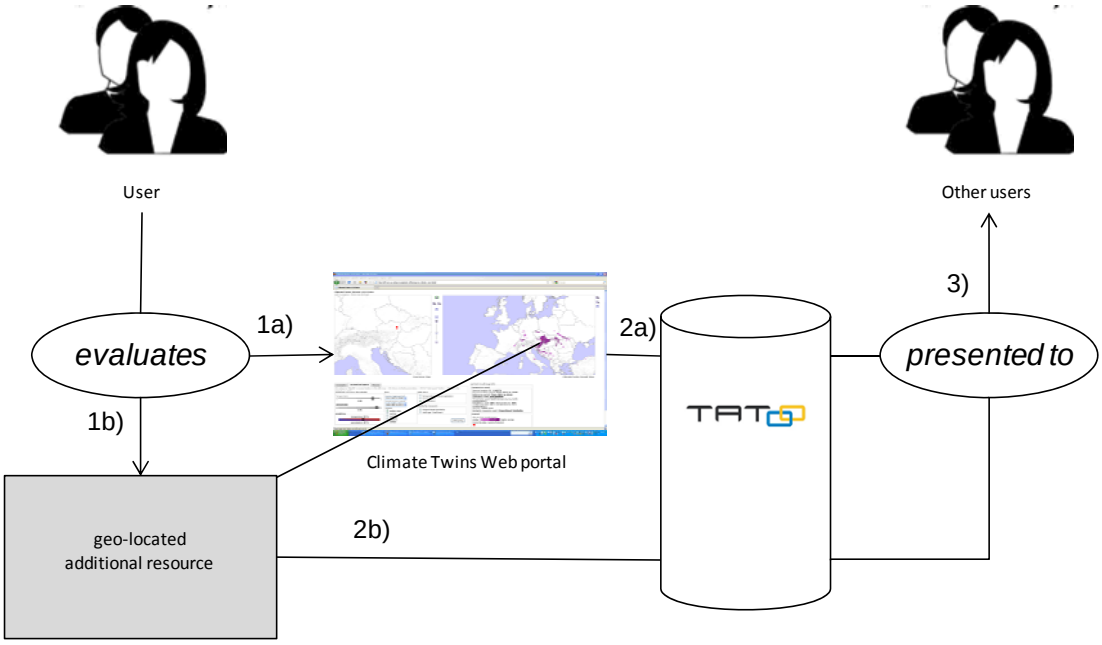

Figure 3: Flow chart UC 2 – Tagging of Climate Twins and its community-added resources

The chart in ***Figure 3*** is more complex, because there are two categories of tags:

- Tags with which users evaluate the Climate Twins application regarding its quality and usefulness (see ***Figure 3***, branch "a").
- Tags with which users evaluate the quality and usefulness of the resources added to Climate Twins by other users (see ***Figure 3***, branch "b").

The first type of tagging concerns the evaluation of the Climate Twins application itself (see ***Figure 4***). Any user who visits the Climate Twins Web portal has the opportunity to leave an assessment of the usefulness of Climate Twins from his/her point of view (step 1a). The assessments of all users are aggregated to the total score (step 2a). This overall evaluation of Climate Twins is visible for all visitors of the Web portal (step 3).

Figure 4: Integration of the Tagging Service of TaToo in the Climate Twins GUI: evaluation of the Climate Twins application (final appearance may be slightly different)

The second type of tagging concerns the evaluation of the additional geo-located resources from the user-community of Climate Twins (see ***Figure 5***). Users can upload any resource they deem interesting or relevant in the context of the actual or future regional climate of specific places (grid cells) in the Climate Twins map (see Use Case 4, section 4.4). Due to the fact that users are free to upload any resource they want, it cannot be avoided in the first place that there will be huge differences regarding the quality between those resources. To minimize "junk" users will have the opportunity to correct inadequate stuff by themselves. Whenever a user accesses an additional resource, he/she can evaluate its quality (step 1b). For each resource the assessments of all users are aggregated to the total score (step 2b). The overall evaluation of any additional resource is visible for all visitors of the Web portal who access the respective resource (step 3).

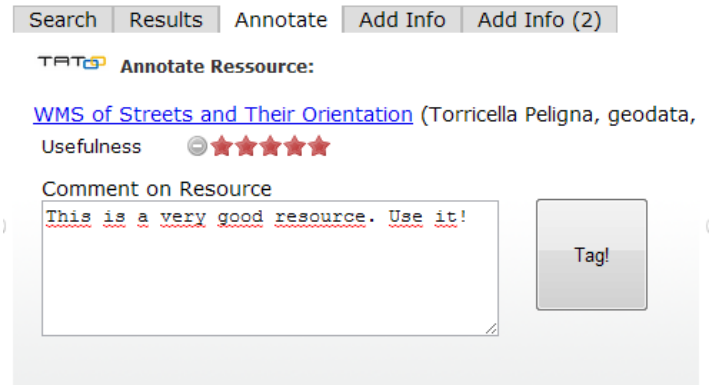

Figure 5: Integration of the Tagging Service of TaToo in the Climate Twins GUI: evaluation of resources added by users (final appearance might be slightly different)

It is expected that especially the evaluation of additional resources will be a very important mean of community-based self-organizing maintenance of quality standards. By giving the users the opportunity to point out wrong or poor resources, the community can safeguard a certain minimum quality standard, which is a very important task that could not be taken over by the provider of the Climate Twins application.

4.3. Find additional information on a particular Climate Twin region

The benefit of TaToo for the UC 3 comes from the provision of a search function to the users of the Climate Twins application which allows them to find additional information beyond the Climate Twins data on their specific places of interest. The beneficiaries are the users of the Climate Twins application.

Climate Twins provides only information on the similarity of spatially disaggregated climate profiles based on the parameters 'temperature' and 'precipitation'. The user of the Climate Twins application might be interested in further information related to regional climate or in a more detailed picture. TaToo offers the possibility to search for such additional information. The respective flow chart of this Use Case is shown in ***Figure 6***. The following ***Figure 7*** shows the integration of the TaToo Discovery Service in the Climate Twins application.

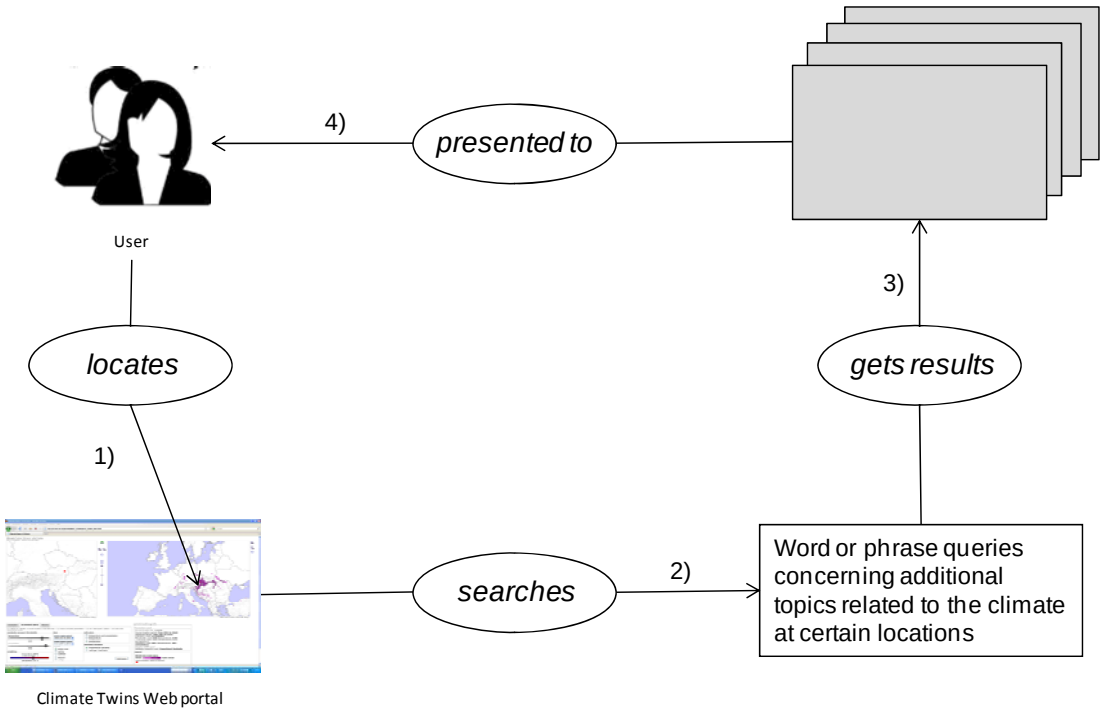

Figure 6: Flow chart UC 3 – Find additional information on a particular Climate Twin region

When a user locates his/her POI in the Climate Twins GUI, he/she either knows already the precise location (city, region) in advance or can easily find out the place by zooming out until a layer with geographical information appears (step 1). Then he/she can enter the adequate name into the TaToo Tool (or enter the precise coordinates, if known) and indicate the desired level of spatial information – the place corresponding to the Climate Twins grid cell (city or village) or higher levels (e.g. district, province, country). A check is necessary, because of cases where place names are ambiguous (e.g. there are two cities named "Waidhofen" in Austria). In such cases, the user has to choose one of the offered alternatives.

After having located his/her POI, the user can search for additional resources linked to this POI or the respective grid cell (step 2). TaToo processes this search and returns suitable results (step 3). The user will find a list of resources linked to the POI which have been added so far by other users (step 4).

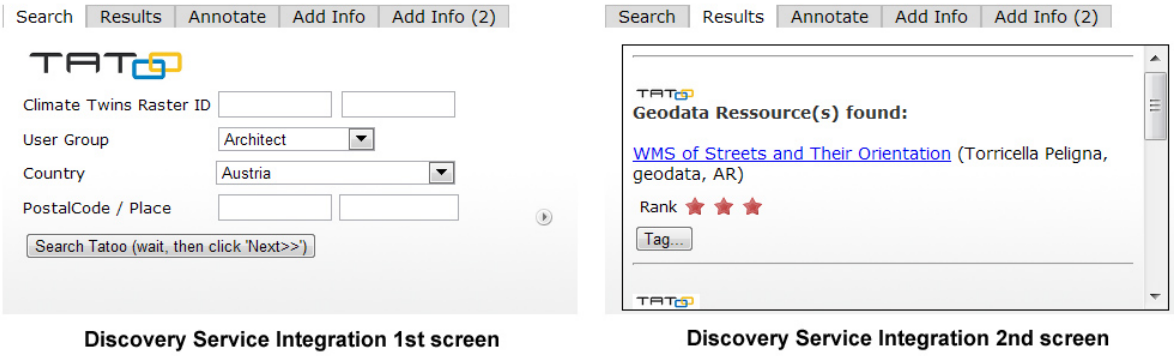

Figure 7: Integration of the Discovery Service of TaToo in the Climate Twins GUI (final appearance may be slightly different)

He/she has then the option to evaluate one or more of these additional resources, if he/she wants (see Use Case 2, section 4.2).

Having the possibility to discover additional information on a particular POI increases significantly the usage value of Climate Twins, because regional climate conditions are not only characterized by the parameters 'temperature' and 'precipitation' alone (i.e., the information-base of Climate Twins). There is an almost open-ended number of topics which are related to climate issues (e.g., vegetation, natural hazards, architecture, transport and energy infrastructure, to name only a few).

4.4. Add additional information on a particular Climate Twin region

The benefit of TaToo for the UC 4 lies in the support of the extension of the basic information from the Climate Twins model (data on temperature and precipitation) by the users of the Climate Twins application themselves for the sake of other users. TaToo enables the upload of geo-located additional climate-related information. The primary beneficiaries are the users of the Climate Twins application, but also the Climate Twins resource provider benefits from the additional geo-located resources added to his temperature and precipitation database.

Before being able to find additional climate-related information for a particular region – Use Case 3 (see section 4.3) – other users have to add such resources. Accordingly, TaToo enables also the upload of geo-located resources. The respective flow chart of Use Case 4 is shown in ***Figure 8***. The following ***Figure 9*** shows the integration of the TaToo Tagging Service in the Climate Twins application.

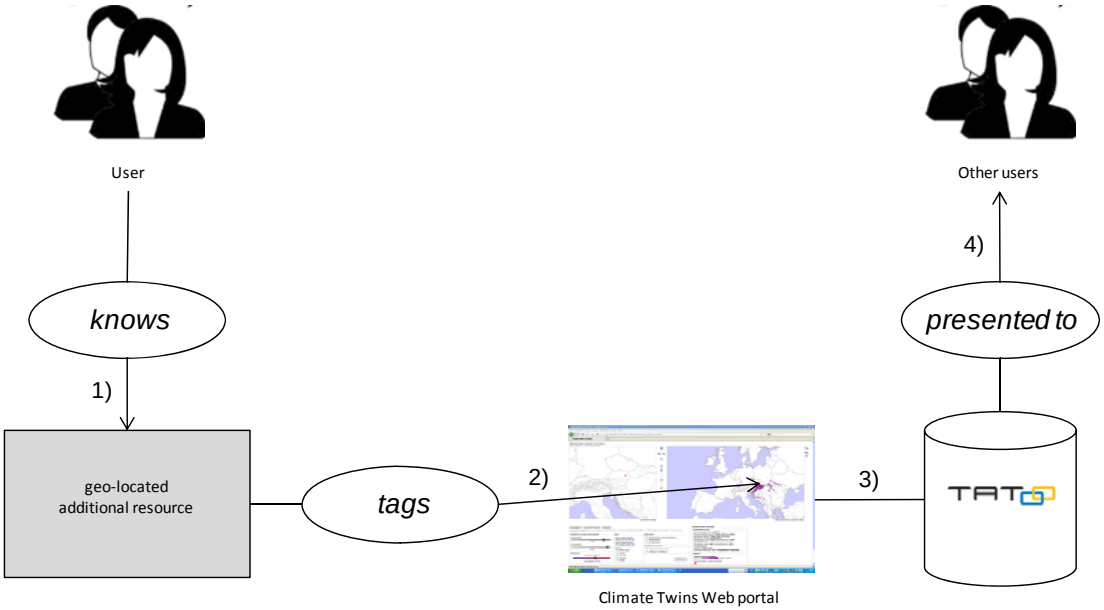

Figure 8: Flow chart UC 4 – Add additional information on a particular Climate Twin region

In the same way as in the Use Case 3 (see section 4.3) the user locates his/her POI in the Climate Twins GUI. For this POI he/she knows interesting additional material which he/she wants to share with other users (step 1). Now the user uploads the URL to this additional resource and adds Meta-Information to it (e.g., intended audience). The tag is stored as a URI in the TaToo Knowledge Base (step 3) and will be presented to any other user who will access this respective POI in the future (step 4).

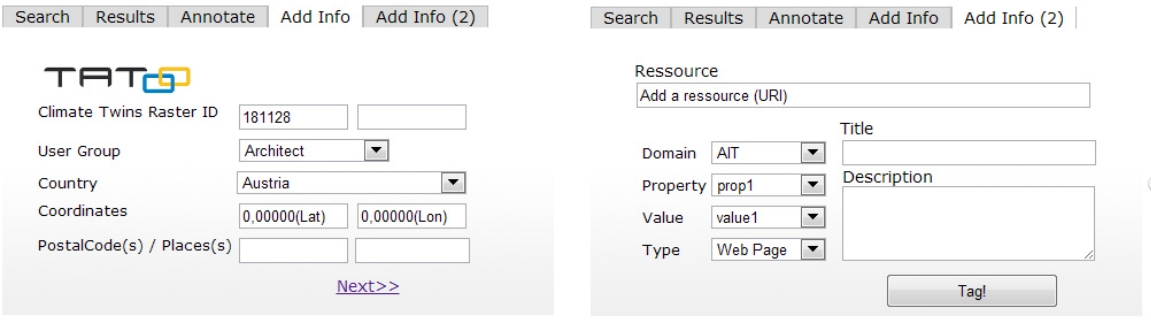

Figure 9: Integration of the Tagging Service of TaToo in the Climate Twins GUI (final appearance might be slightly different)

As described in section 4.2, additional community-based resources can be evaluated. In the case a resource has already been evaluated, the evaluation tag is presented to the user together with the resource itself.

5. Conclusions

The idea of Climate Twins is to provide insights about future climate conditions and the resulting implications for a certain location by identifying regions that have a similar climate now which is to be expected at the respective location in the future. The Climate Twins application enables the comparison of present and future climate conditions in European regions and the identification of pairs of regions where the current climate matches with the expected future climate (the so-called "Climate Twins"). The climate parameters used for this comparison – temperature and precipitation – are predictions based on a regionalized climate simulation model.

TaToo has helped to improve the functionalities, the usability and the discoverability of Climate Twins with regard to the following Use Cases (UC):

- UC 1: Discovery of Climate Twins
- UC 2: Tagging of Climate Twins and its community-added resources
- UC 3: Find additional information on a particular Climate Twin region
- UC 4: Add additional information on a particular Climate Twin region

Regarding Use Case 1 the targeted audience comprises a wide range of people who differ significantly with regard to their type and depth of knowledge, their interests, their perspectives and the terminology and phraseology they use. TaToo provides the possibility to search semantically for such sets of terms and phrases. Supporting the searches of people with very different professional backgrounds with semantics is able to direct their searches for issues related to the future climate in particular regions also to the Climate Twins application (besides other resources). Climate Twins can then be found without having to formulate searches in a particular domain-specific way. People searching the Web for information about the future climate of a specific region can do this either by turning to well-known general-purpose search tools or by using more focussed services which collect and provide specific resources on climate-related issues. Usually, searching is done by entering keywords or selecting thematic categories, and it is limited to syntactic search. Semantic search, on the contrary, enables the search of full phrases. This allows users to formulate searches in ways which are much closer to their respective professional backgrounds and languages. As a consequence, semantic search by TaToo increases the probability that Climate Twins will be found by more people than with syntactic search only.

Use Case 2 refers to the enrichment of the Climate Twins application through Meta-Information added by users. Giving the users a possibility to evaluate the Climate Twins application and its community-added resources regarding usefulness of the one and quality of the others enables the Climate Twins resource provider to further develop the model according to the final users' needs, and helps other users to distinguish valuable from weak resources. Users provide their evaluation by placing tags on the Climate Twins application and/or on geo-located additional resources added by other users. These tags are visible for all users who access the Climate Twins application or specific geo-located additional resources. Especially the evaluation of additional resources will be a very important means of community-based self-organizing maintenance of quality standards. By giving the users the opportunity to point out wrong or poor

resources, the community can safeguard a certain minimum quality standard, a very important task that could not be taken over by the provider of the Climate Twins application.

Use Case 3 refers to the important possibility of users of the Climate Twins application to discover additional information on a certain region they are interested in and which they have located on the Climate Twins map. Since Climate Twins provides only information on the similarity of spatially disaggregated climate profiles based on the parameters 'temperature' and 'precipitation', this possibility increases the usage value of Climate Twins significantly. Regional climate conditions are characterized by many more parameters than temperature and precipitation alone. Accordingly, the user of the Climate Twins application might be interested in further information related to regional climate or in a more detailed picture. TaToo offers the possibility to search for such additional information.

Before being able to find additional climate-related information for a particular region other users have to add such resources (Use Case 4). Accordingly, TaToo enables also the upload of geo-located resources. By providing the possibility to add additional information and to geo-locate it, TaToo supports the extension of the basic information from the Climate Twins model (data on temperature and precipitation) by the users of the Climate Twins application themselves for the sake of other users.

6. Acknowledgements

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7. References

Climate Twins Viewer AIT ClimateTwins Viewer v3.0, http://foresight.ait.ac.at/projects/climatetwins/

COSMO-CLM COnsortium for SMall scale MOdelling – Climate Local Model, http://www.cosmo-model.org/

ECHAM5 5th generation of the ECHAM general circulation model, http://www.mpimet.mpg.de/en/wissenschaft/modelle/echam/echam5.html

MPIOM Max- Planck- Institute ocean model http://www.mpimet.mpg.de/en/wissenschaft/modelle/mpiom.html

Ungar J., 2010 A comparative analysis of region pairs matching current and future climate conditions. Diploma thesis, University of Vienna, Department of Geography and Regional Research.

