IEC integration with urban heat storyline and the process of visualisation

The Information Enrichment Chain (IEC) is an approach to support information transfer for adaptation planning (Groot-Reichwein, M.A.M. de, et al. (in press)). It provides a step-wise method to get from the information needs of users to a map presentation of a climate indicator. CLIPC is a project that could follow the same step-wise approach to know which climate indicators are preferable and how these indicators should be visualized. The following figure (figure 1) and figure subtitle illustrate the Information Enrichment Chain and are taken from Groot-Reichwein, M.A.M. de, et al. (in press).

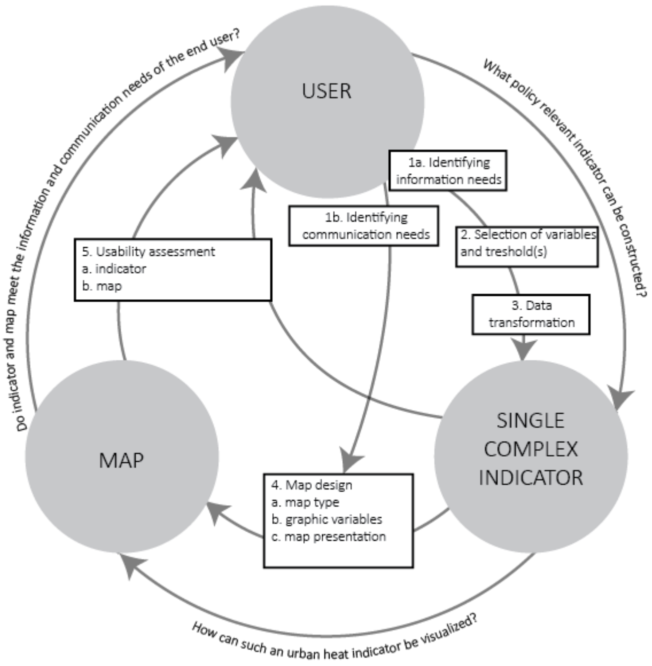

Figure 1: The information enrichment chain approach to support information transfer for adaptation planning. The information enrichment chain contains five steps that centralises the interaction between user, indicator and map. First a single complex indicator to indicate the urban heat effect for local climate adaptation planning processes is defined based on information needs (1a), selection of variables and thresholds (2) and data transformation (3). Next a map is designed based on the constructed indicator, communication needs (1b) and cartographic techniques (4). Finally both indicator (5a) and maps (5b) are tested to evaluate whether they do meet user needs.

The following text tries to illustrate how the IEC can help in the visualisation of CLIPC data by explaining per step (if possible) how the urban heat storyline is created and can be transferred to develop story lines on other themes. The texts are based on the indicative urban heat storyline created by Luis Costa (WP 7) and Architecture team report 1.0.

1a. Identifying information needs from user (determine the core variables of interest and the derived indicators to discuss effects and sensitivity)

What do your users want to know about the urban heat island potential and which indicators can be

User story line: In the region of Haaglanden, the various individual municipalities were unconvinced of the need urgency to join the Regional Adaptation Strategy process. The coordinator of the Regional Adaptation Strategy asked for a policy relevant map indicator that would summarize if heat related events should be something to address.

In interviews the RAS coordinator stressed the need for a simple map indicator that would summarize the results of ongoing research derived from that need.

General: The most important indicators (for all themes) need to be identified by future users of the CLIPC portal. This is done in WP2 by including the possible future users in identifying the climate data indicators that are most important for their work. No new climate data will be created in CLIPC, but existing climate indicators need to be prioritised.

1b. Identifying communication needs from user (centred the message, goal and outcome of a visualisation)

Different communication ways should be made available to be assessed by the future users and by the people involved in CLIPC.

User story line: The communication need of the RAS coordinator was to create involvement of the municipalities. The urban heat phenomena could potentially trigger municipalities to join the RAS initiative. The first need was to identify if and to what extent heat related events will become an issue to take into account.

General: As part of WP2, users will be continuously involved in the creation process of the portal and therefore their communication needs will be addressed.

2. Selection of variables and threshold(s)/ Analysing temperature measurements for Urban Heat Island characteristics

The following variables and thresholds are described for the urban heat storyline. There should be climate data available on:

- Tier 1 data: temperature climate dataset: daily minimum and maximum temperatures (satellite and land-cover data):
  - Daily minimum and maximum temperature
  - Current climate (current, 30 year average)
  - Future climate scenario's (which RCPs are most suitable?)
  - Resolution: at least $3km^2$
  - Derived indices (adjustable for specific area's): the average number of days a year, where the night temperature is not lower than 20 degrees Celsius. In this calculation the threshold of 20 degrees should be adjustable (e.g., for South Europe it could be 25 degrees Celsius)
  - Calculation: use Climate4impact services for indices calculations.
- Tier 2 data: Combine T1 with land use characteristics like thermal characteristics of cities.
  - Land use map of Europe (should contain at least: height, % green, %buildings/roads)
  - Surface albedo map for Europe (CORINE dataset?)
  - Land use scenario's for future land use in Europe
  - Building surface fraction
  - Impervious surface fraction
  - Green surface fraction
  - Element height
  - Sky view factor
  - Calculation: Use the WUR urban heat island effect formula.
- Tier 3 data: Combine with sensitivity data: how humans react to heat stress (comfort/health issues).
  - Possibility to make use of green areas
  - Population density
  - Total population
  - Share of the population older than 65
  - Demographic dependency

- Share of people with lower socio-economic status (poorer housing quality and lack of air-conditioning)
- Calculation?

A TM-threshold informs on the temperature level beyond which the recorded mortality of a region diverges significantly from its expected value. Heat tolerance ranges from 13 to 25 degrees.

3. Data transformation/ Extrapolating UHI characteristics into UHI percentage for current and future land use / Translating UHI into number of nights for current and future climate

A sensitivity function makes the step from tier 2 to tier 3 data. The sensitivity function informs on the capacity of population to tolerate heat and for the case of urban heat, a function is currently being developed by a Phd student at PIK.

General: for every indicator the underlying data and the methods to transform the data should be identified. The indicators that will be made available on the portal are already being inventoried. Therefore insight in the underlying data and formulas is also already being developed. Prioritization of the indicators should come from the users.

4a Map type

In WP2 a small exercise can be done with users to see if their preference deviates from previous experiences if time allows. In Groot-Reichwein, M.A.M. de, et al. (in press) 6 map types were tested: (isoline, isopleth, choropleth, point symbol, diagram and grid) for presenting an urban heat indicator.

General: experience from previous mapping exercises gives an indication for some user preferences towards map type.

4b. Graphic variables

Different types of graphic variables were also tested (Groot-Reichwein, M.A.M. de, et al. (in press)). The following statement is given in this paper on graphic variables: "Variations in shape, orientation and colour hue can be best used to represent qualitative (nominal) variations in attribute data, while texture (ordinal), value (interval) and size (ratio) convey a correct perception of quantitative data."

General: experience from previous mapping exercises gives an indication for some user preferences towards graphic variables.

4c. Map presentation

The entire visualisation process of a climate indicator cannot be fully automated. Expert knowledge/judgement is needed to convert model outcomes into userfriendly maps and to validate the results of these maps. Therefore Alterra will use the model outcomes of the KNMI to create policy-relevant and usable maps on the Urban Heat Island (UHI) effect. These maps aim to inform the different target groups of CLIPC on the UHI effect. The translation of the model output on urban heat into policy-relevant and usable information may (better) support local adaptation processes. Validation of the maps has to eventually be done by local experts.

Input for the visualisation process are the model outcomes from the KNMI. These outcomes show for different climate and land use scenarios the number of nights for which the minimum temperature will not drop below (x) degrees Celsius (for the Netherlands a threshold of 20°C is used). The threshold (x°C) is a temperature, if surpassed, people will be affected by in a negative way (health effects, economic effects). The threshold is probably not a standard number for the whole of Europe. It depends on local factors such as the average age of people, the climate they are used to and the quality of the buildings they live in (adaptive capacity/sensitivity). It is expected that residents of cities in the south of Europe are more used to higher temperatures compared to people that live in the northern regions of Europe. Such differences among Europe may affect the threshold for a certain area.

Different scenarios for the development of Europe's landuse and climate are used to project how the UHI effect will develop in the coming decades. Every used climate scenario (present, RCP 2.6, RCP 4.5 and

RCP 8.5) together with a landuse scenario results in a specific map that contains information about the expected UHI effect for a certain climate scenario and landuse scenario for a specific city.

The above described method results in model outcomes for different scenarios that can be seen as raw data. This raw data has to be translated into userfriendly maps to inform the users on the UHI effect. The program that will be used for this step in the process is the Adobe Illustrator program. This program does not read GIS files and therefore needs .AI or .JPEG files. The raw data maps on the UHI effect in Europe have to be exported by the KNMI as .AI or .JPEG files.

The outcomes of the Illustrator step that will be conducted by Alterra are maps as illustrated with an example in figure 2. This map shows the UHI effect for the present climate scenario in combination with the regional communities landuse scenario for 2050. The threshold that has been used in this study is 20 degrees Celsius. For the Netherlands this threshold seemed to be a realistic estimation of the night temperature for which residents of The Hague region are facing negative effects.

Figure 1 shows a map with one possible combination of a climate scenario with a landuse scenario. Because a different amount of climate scenarios (A) and a different amount of landuse scenarios (B) are used, the result will be A*B different maps that all say something about the possible changes of the UHI effect in Europe.

To avoid a large document that contains numerous different UHI maps, Alterra will use the program Adobe Indesign. This program is able to convert all different UHI maps into one single interactive PDF/SWF. This interactive file gives users the opportunity to easily observe the impacts of climate change and different land use scenarios on the UHI effect in their region. As an example the Urban heat tool for the city of The Hague region is given in figure 2.

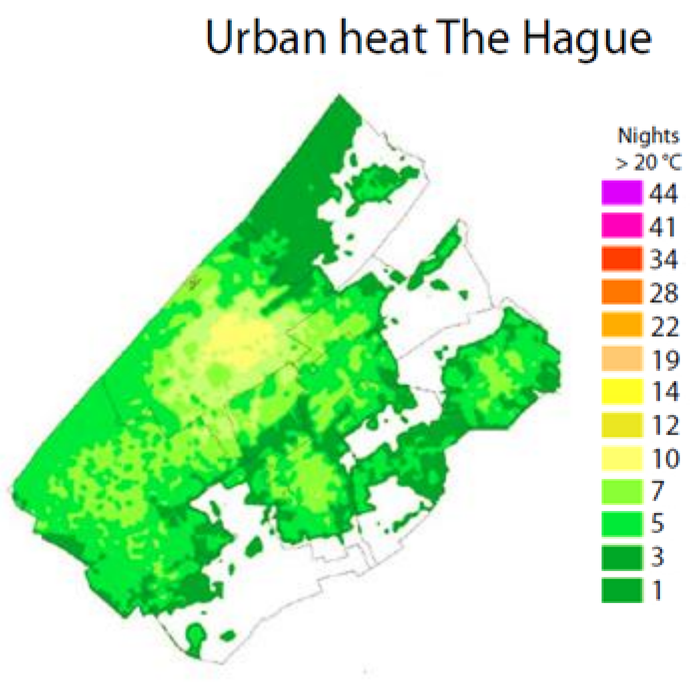

Figure 1: Illustration of an UHI map for The Hague region in the Netherlands

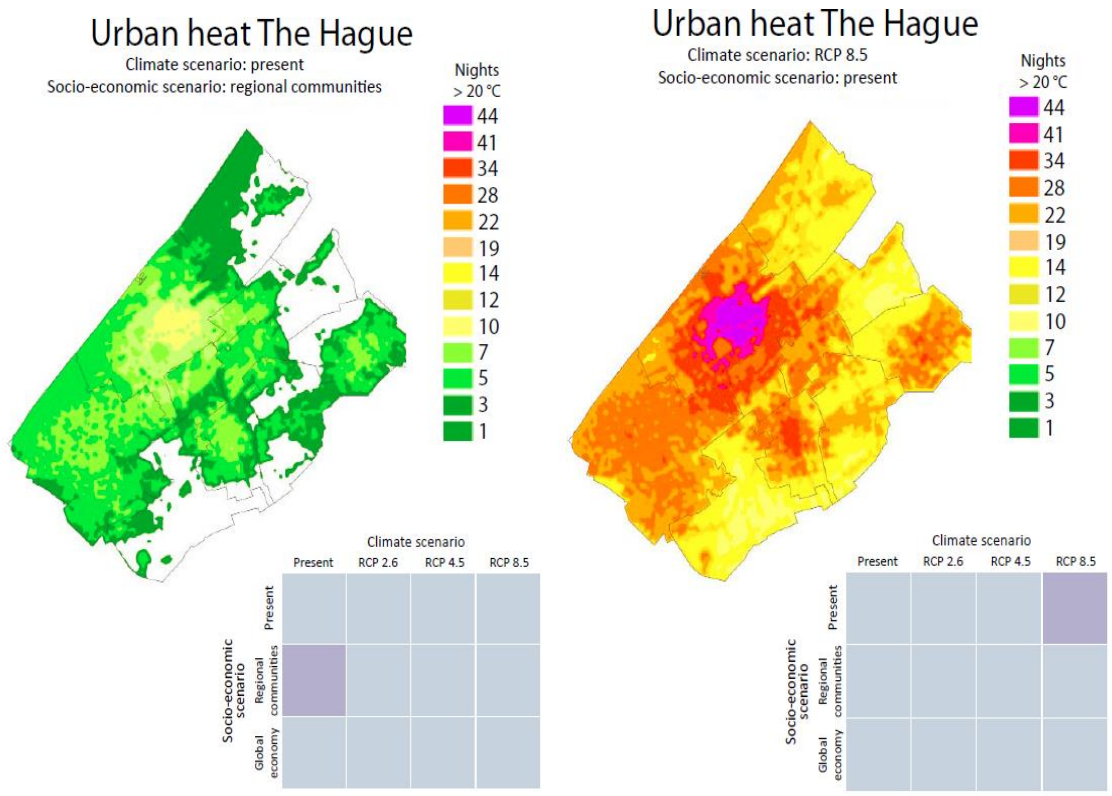

Figure 2: Interactive tool for Urban heat in The Hague region

The Urban heat tool for The Hague consists of a matrix with on the X-axis the different climate scenarios and on the Y-axis the different land use scenarios. By moving over one of the blocks, that represent the combination of a climate scenario and a land use scenario, the map that belongs to that combination will be shown.

General: The tier 3 indicator visualizations as a product for policy makers cannot be fully automated. Automatic visualization of tier 1, tier 2 and tier 3 data for scientific use is possible, as well as generating these maps for further appliance in creating the tier 3 product for policy makers. The example of The Hague is a good example of visualizing the tier 3 indicator data for policy makers.

5a and b. usability assessment of indicator/map

After creating the tool for the maps, this tool needs be evaluated by a user panel to find out whether this is an effective and usable way of visualising the effects of climate change and land use change for different cities in Europe.

The validation step, which has to be conducted by local experts, is a step that will not be dealt with in the CLIPC project.

General: after a map presentation is made, users should be questioned on the ability of the map to retrieve the information they seek.

References:

M.A.M. de Groot-Reichwein, R.J.A. van Lammeren, H. Goosen, A. Koekoek, A.K. Bregt and P. Vellinga (in press). Urban heat indicator map for climate adaptation planning.