Tools for biometeorological and climatological studies

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1. INTRODUCTION

Nowadays, the processing of existing data sets from networks and climate models offer several possibilities for applications in different disciplines. These data can be used in different temporal and spatial resolutions and can be important for decision making also in terms of climate change discussion. But not only original climate data i.e. air temperature or precipitation are demanded from several disciplines and purposes. In addition, these allow us to process them and produce valid information for applied climatology or biometeorology, not only from the original data but also from processed data (a.e. calculation of thermal indices) (Matzarakis, 2007). The main advantages of these data (measured or modelled) can limit their use, because of the huge size and complexity of processing. Since the files are so huge, commonly used software packages cannot handle these data easily or the software is to expensive.

2. METHODS AND DATA

In the last decades, new information and software technologies were developed which provide us many opportunities for data processing. Nevertheless, the data has to be available and suitable for the particular analysis (Matzarakis et al., 2004, 2007a). At the moment two possible sources exist: data from climate networks and modelled data. Climate model data for tourism purposes has to be at least at a meso scale resolution (best resolution at the moment 10 km) (i.e. Jacob et al., 2001). The data allows us to process them and produce valid information for tourism purposes, not only from the original data but also from processed data (a.e. calculation of thermal indices) (Matzarakis, 2007, Matzarakis et al., 2007c).

As part of the CAST-Project (Bartels et al., 2007) and Startclim.2006.D2 (Matzarakis et al., 2007b) several tools have been developed. Additionally, the RayMan model is also suitable for the use in applied climatology and other related sciences (Matzarakis et al., 2007c).
The data can be drawn from climate networks and long data series (Matzarakis et al., 2007a, Matzarakis, 2007) or from climate models. In our study the original data is based on the regional climate model REMO from the Max-Planck-Institute of Meteorology in Hamburg (Jacob et al., 2001). The model region encompasses Germany and the Alps. The data has a spatial resolution of 10 km and a temporal resolution of hours. The data is available from 1950 until 2100. In that way, the period 1961-1990 of the A1B, A2 and B1 scenario can be used as the reference period for future climate change. Based on hourly or daily values of the scenarios, tourism climatological information can be extracted.
For this study, we developed several ways (tools and software) of processing the data from climate networks and climate models:

a) REMO extractions and processing procedures,
b) RayMan model for the calculation of thermal indices and other radiation properties (Matzarakis et al., 2007),
c) Software for the creation of CTIS diagrams,
d) “Calculate” for the analysis of huge data files in terms of means, totals and frequencies,
e) “Climate Mapping Tool” for the creation of maps in applied climatology and biometeorology.

3. TOOLS AND EXAMPLES

REMO DATA PROCESS UNIT
The REMO data extraction tools (Fig. 1) can extract data from the REMO model (more than 60 parameters) in form of exactly defined grid points or areas for defined regions by coordinates. The software extracts data for different time periods starting in 1961 and ending in 2100. The available scenarions A1B, A2 and B1 can be selected also specific months in order to reduce the data size. The

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relevant parameters can be selected and then downloaded.

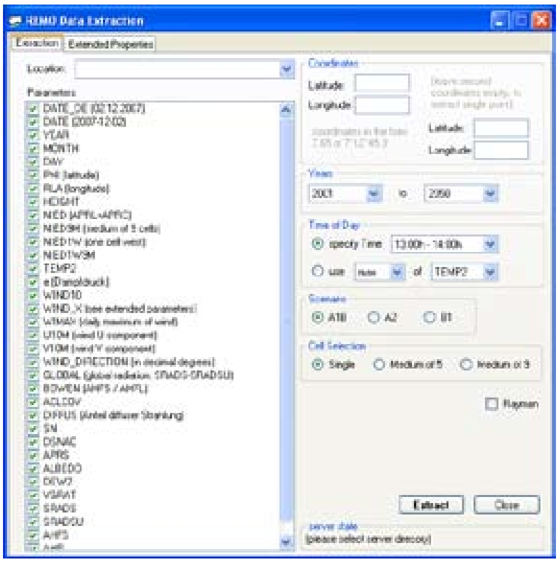

Fig. 1. Remo-Data extraction software.

Additionally, a second data file can be produced, which can be used directly for RayMan calculations. The program is written in Python language and works on windows-based computers.

RAYMAN MODEL

The model „RayMan“ estimates the radiation fluxes and the effects of clouds and solid obstacles on short wave radiation fluxes (Fig. 2, right). The model, which takes complex structures into account, is suitable for utilization and planning purposes on a local and regional level (Fig. 2, left). The final output of this model is the calculated mean radiant temperature, which is required in the energy balance model of humans. Consequently, it is also required for the assessment of urban bioclimate and thermal indices, such as Predicted Mean Vote (PMV), Physiologically Equivalent Temperature (PET), and Standard Effective Temperature (SET*). The development of the model is based on the German VDI-Guidelines 3789, Part II: Environmental Meteorology, Interactions between Atmosphere and Surfaces; Calculation of the short- and long wave radiation and VDI-3787: Environmental Meteorology, Methods for the human-biometeorological evaluation of climate and air quality for the urban and regional planning at regional level. Part I: Climate (VDI, 1998). For the calculation of thermal indices based on the human energy balance meteorological data (air temperature, wind speed, air humidity and short and long wave radiation fluxes) and thermo physiological (activity and clothing) data is required. Data on air temperature, humidity and wind speed is required to run RayMan (Matzarakis et al., 2007). The software is written in Borland Delphi.

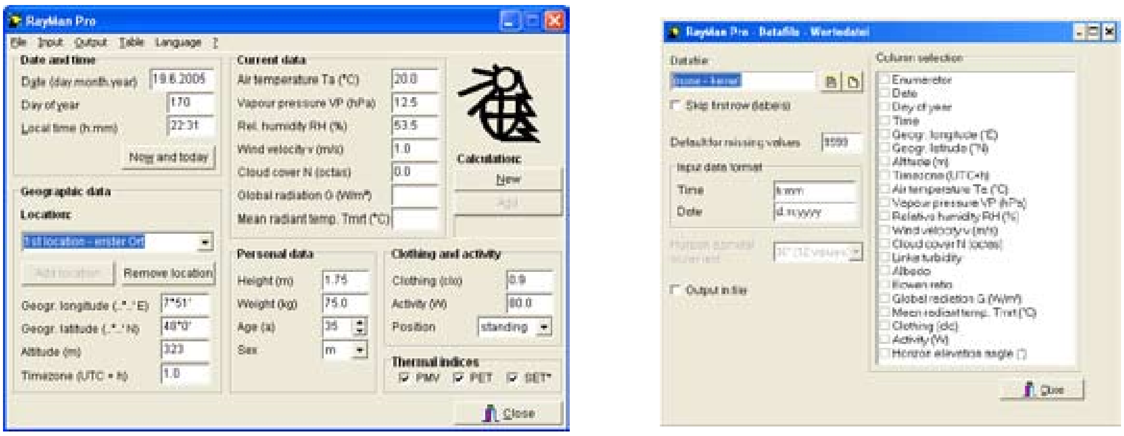

Fig. 2. RayMan software for the calculation of thermal indices and radiation.

CLIMATE-TOURISM-INFORMATION-SCHEME SOFTWARE

Existing assessment methods in applied climatology are based on the analysis of means or percentages (Matzarakis et al., 2004, 2007a) and usually for specific evaluation i.e. quantification of winter or summer tourism. Based on the Climate Tourism Information Scheme (CTIS) (Matzarakis, 2007), which is based on the frequency distributions of specific factors and facets of climate in different purposes in applied climatology and biometeorology, a software tool has been developed in order to produce CTIS-diagrams. The diagrams can be produced for resolutions of months, decades and weeks. Considering factors and parameters and colours can be chosen and visualized (Fig. 3). The output can be stored in ordinary graph formats, a.e. jpg or png. The proposed procedure in form of percentual distributions is easier understandable than values on precipitation amounts or mean monthly temperatures.

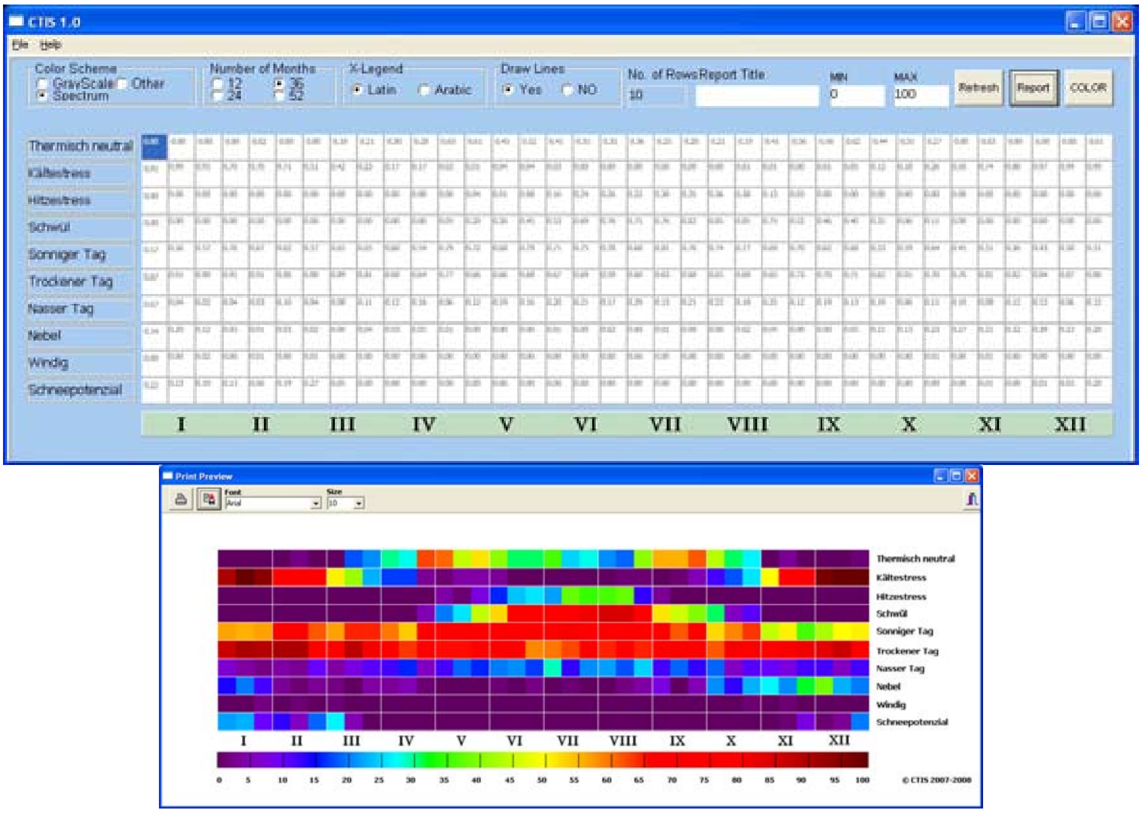

Fig. 3. Software for the creation of the Climate-Tourism-Information-Scheme.

CALCULATE

For the analysis of long term and huge data files of single stations or big regions, the difficulty of processing of the data is evident. For these analysis the mean monthly conditions, mean monthly totals or frequencies of thresholds values are required. This deficiencies can be solved by the software tool calculate in order to analyse or prepare the data for further analysis or visualization (Fig. 4, right).

CLIMATE MAPPING TOOL

Data in climatology and meteorology can be spatially represented or visualized by the use of GIS techniques, but these are expensive and not easy to use. Here, we produce a tool which can generate maps based on ASCII files. We can create colour plots, isolines or combined graphs. The processing of data is very easy and user friendly. This possibility of showing or visualizing data is easy understandable and easy to use. Several data sets can be imported and processed in the Climate Mapping Tool (Fig. 4, left).

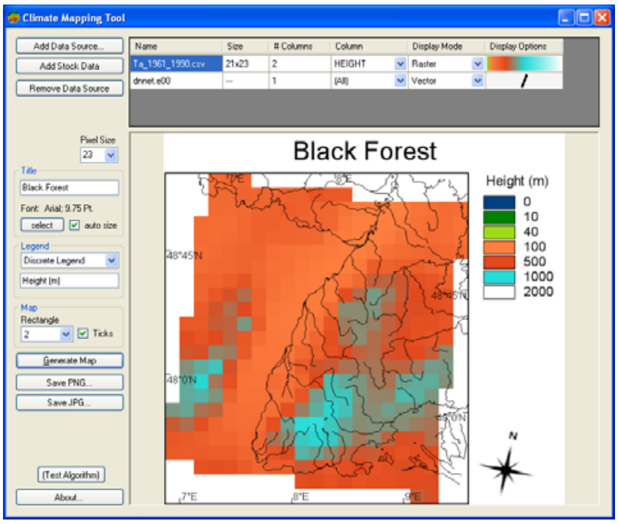

Fig. 4. "Climate Mapping Tool" software (left) and "Calculate" (right).

4. CONCLUSIONS

The development of new process and visualization techniques provide new opportunities, but they are expensive and time demanding i.e. ordinary GIS programs. The possibilities and tools presented here do not require much time for learning and they are user friendly. They do not have any limitations regarding data size and also have less running time for processing. They are free available and easy understandable. The tools presented here offer a range of possibilities, not only in the fields of applied climatology and tourism climatology.

ACKNOWLEDGEMENT

This research is supported by The Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung, BMBF) in the Framework of Klima*zwei* and by the StartClim 2006 Project funded by the Central Institute of Meteorology and Geodynamics, Vienna and the Austrian Ministry of Science.

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