**INKAS Users Guide**

**What is INKAS? Whom is INKAS designed for? What is the best way of using INKAS?**

These are just a few of the questions which we hope to answer in the following few pages.

INKAS (Information Portal Climate Adaptation in Cities) is an interactive online advisory tool based on results from a large set of idealised urban climate computer simulations. It has been particularly designed for small and medium-sized cities facing the challenge of urban development in a changing climate without access to suitable climate studies for their city. INKAS can support cities in their design of measures and adaptation strategies for urban heat load mitigation. The tool is helpful in determining the potential risk of summer heat load in typical urban settlement types. The tool can also be used to evaluate air temperature impacts of specific urban planning measures in the city and to compare various alternative measures. INKAS helps to prioritise adaptation measures from an urban climate point of view and can be used to develop specific recommendations (e.g. 20 % restoration of permeable surfaces and 10 % green roofs).

The INKAS modules (1) impact analysis and (2) surface analysis are available on the Deutscher Wetterdienst INKAS website. The modules also include further important user information, e.g. on the ‘idealised city’ method, the applied urban climate model, a list of related literature, and a description of all available user options.

**Impact analysis**

The INKAS ‘impact analysis’ module provides users with quantitative analyses evaluating the effectiveness of measures to reduce summer air temperatures in urban areas, based on the options chosen by the user (size of city, settlement type, surrounding area, and adaptation measure). The user can select several adaptation measures from two categories (1) built-up and surface properties and (2) green areas and water surfaces. Available results are based on more than 3,200 idealised urban climate simulations. The options of settlement type, surrounding area and adaptation measure currently implemented in INKAS are listed below.
Nine settlement types:

- Single- and multi-family houses
- Village centre and single-family houses
- Terraced housing estate
- Aligned mid-rise buildings
- Aligned mid-rise and high-rise buildings
- Tenement blocks
- Later mid-19th century city
- Mediaeval city centre
- Commercial and industrial buildings

Four surrounding areas:

- Sparse settlement
- Open landscape
- Open landscape with forest
- Open landscape with villages

Ten adaptation measures:

- Built-up and surface properties
  - Roof albedo
  - Wall albedo
  - Albedo of impervious surfaces between buildings
  - Fraction of green roofs [%]
  - Fraction of impervious surfaces between buildings [%]
  - Mean building height [m]
  - Built-up surface fraction [%]

- Green areas and water surfaces
  - Park size [ha]
  - Water surface area (water temperature 20 °C) [ha]
  - Water surface area (water temperature 24 °C) [ha]

The modelled impacts of adaptation measures for the ‘built-up and surface properties’ category are shown in the form of scatter diagrams for the maximum and minimum air temperature on a typical calm summer day in July. The diagrams show the absolute air temperatures as well as the difference in the air temperatures after and before (reference) applying a measure. All the results are for the lowest (near-surface) atmospheric layer. The results for the ‘green areas and water surfaces’ category are
also shown in the form of scatter diagrams for the near-surface atmospheric layer. The diagrams show the impact on maximum temperature within a park or above a water surface (difference from the reference run without park or water surface). Furthermore, the plots show the impact on neighbouring built-up areas based on the maximum temperature difference and the size of the built-up surface area thermally influenced by the park or water area.

It is now also possible to compare the results from two model simulations (experiments) directly. In the ‘built-up and surface properties’ category these comparisons show the change in maximum and minimum temperatures for the selected settlement type, while in the ‘green areas and water surfaces’ category temperature changes for the selected settlement type are shown only for the built-up area surrounding the additional green or blue infrastructure.

**Surface analysis**

The ‘surface analysis’ module of INKAS shows the sensitivity of the selected settlement type to heat related temperature thresholds. The modification of the urban air temperature is based solely on changes in the built-up and impervious surface fractions of the selected settlement type. All available results relate to the surrounding area ‘open landscape’.

All urban settlement types are composed of three different types of surface fractions: built-up surface, impervious, and pervious surfaces between buildings. In the model simulations, the fractions of these surface areas have been varied to study the thermal impacts of urban development. The results of the simulated changes in air temperature are displayed in ternary diagrams (triangle plots). This type of diagram allows quick identification of the distribution of surface fractions within a specific settlement type (e.g. terraced housing estate) and, from an urban climate perspective, the resulting proneness to summer heat load.

The near-surface air temperatures computed by the urban climate model for the selected settlement type are displayed by a colour code. The median values\(^1\) of daily minimum and maximum temperatures for the selected settlement type are shown as difference to critical temperature thresholds:

\(^1\) The median value divides a set of values into two equal parts. The median value is thus a location parameter which represents the middle of an ascending sequence.
• daily minimum: difference to the threshold value of 20°C (minimum temperature \( \geq 20^\circ\text{C} \) defines a tropical night), and

• daily maximum: difference to the threshold value of 30°C (maximum temperature \( \geq 30^\circ\text{C} \) defines a hot day).

The colours show whether the selected settlement type and its associated built-up and sealed surface fractions are prone to summer heat load (red) or whether the threshold criteria is not exceeded in the simulation results (blue). The diagrams provide a guide to whether a higher building density (by adding buildings to existing development) or a higher sealing fraction of areas between buildings will increase sensitivity of the selected settlement type to summer heat load.

In addition to the results for the various predefined settlement types, the ‘surface analysis’ module also provides a synopsis of all results (all settlement types aggregated in one ternary diagram).