"CLIM-APP" - AN ANDROID BASED APPLICATION FOR URBAN HEAT ISLAND ASSESSMENT

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Abstract: One of the most renowned anthropogenic impressions on urban climate is the 'Urban Heat Island Intensity' (U.H.I.I.). To enable an effective scientific understanding of this urban occurrence in the tech-savvy world, the present research introduces an android based Application 'Clim-App'. The cellular application is novel as it's the 1st application of its kind equipped with precision based representation of 'population characteristics' for a huge parallel variable climatic database; owing to its inbuilt 'Relative Magnitude Analysis', feature. The app assists in GUI based user-friendly data collection, data-storage and data-analysis. Conceptualized as a crowdsourced mobile data collection system, the App leverages upon ubiquitous low-cost smartphones.

Introduction: Urban Warming and Global Warming are the most deliberated issues in urban climatological research [1]. While Global Warming is oriented w.r.t. an average worldwide rise in ambient air temperature; Urban Warming (Figure 1) is more of a localized phenomenon [2].
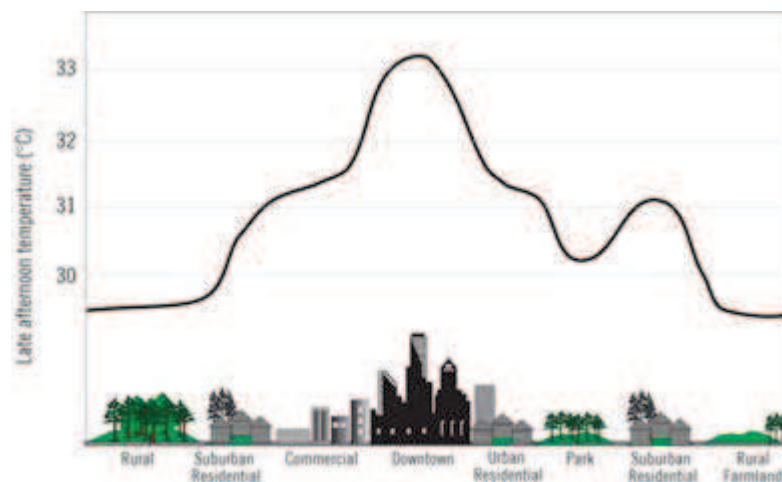

Fig. 1 Urban Heat Island Profile [4]

While focus has been most often on the former; off-late the latter has gained prominence with Statistical Research quantifying the intensity of Urban Warming being widely documented by several experts across the globe [3].

However, most of these studies fail conceptually as in all climatic researches the sample design is a vital component and is often left to the predicament of the researcher [5]. Also, Climate as a tool is rarely encountered in Town-planning guidelines, since most modern cities have developed with little or no regard to the climatic environment in which they are embedded [2]. These drawbacks synergistically pose a major threat to violation of the human-thermal comfort factor [6].

Scope of Present Study: There is a dearth of economic-user friendly alternatives for climate data. In this context and in an era of ubiquitous smart phones; only a mobile app can be of most leverage. The present research offers a mobile based free-application 'Clim-App' which enhances awareness, scientific & logical

understanding in the tech-savvy generation, about "Urban Heat Islands". This mobile application has been fortified with the author-defined logic of 'Relative Magnitude Analysis' (R.M.A.) that overcomes the limitation previously discussed under the ambit of climate research [5].

App Development Platform: According to a report from Gartner, Android accounts for 86.2% of the worldwide smartphone operating system market [7]. Strategy Analytics has also revealed that 97% of smartphones in India ran the Android operating system in the previous year [8]. Android is a mobile operating system developed by Google [9]. It is an open source, Linux-based software stack created for a wide array of devices. The major components of this platform incudes Linux Kernel, Libraries, Android Runtime, Application framework and Applications [10].

Features of Clim-App: The App can be launched by clicking on the Clim-App icon (Figure 2) in the Application Panel in Mobile.

Fig. 2 Launch Icon of Clim-App

The App layout is based on a simple User Interface design pattern commonly known as navigation drawer. It can be operated by swipes on the screen edge, and also by clicking on the hamburger icon on the toolbar. The navigation drawer opens a panel on the screen and further reveals 7 navigation options, namely, User Manual, Observatory Setup, Climate Database, Global Warming Analysis, Urban Warming Analysis, Climate Science and About App (Figure 3).

Fig. 3 Navigation Panel of Clim-App

Click action on each of these options leads to a new workflow guiding users to explore the inbuilt functions. To begin with, the 1st option of User Manual shall lead the user further to three links that deals with Tutorials on how to use the App, Frequently Asked Questions and Troubleshooting Guidelines. The 2nd option i.e., Observatory Setup shall assist users to view the saved list of existing observatories and also allows new registrations (Figure 4).

Fig. 4. Navigation Menu of Observatory Setup

The screen lists all the existing registered locations with an edit/delete option. It provides an action option with a "+" symbol at the bottom of the screen to add new observatories. This is facilitated by manual mode and as well, with aid of GPRS i.e., by taking into account the time-zone and longitude/latitude of the location along with other attributes.
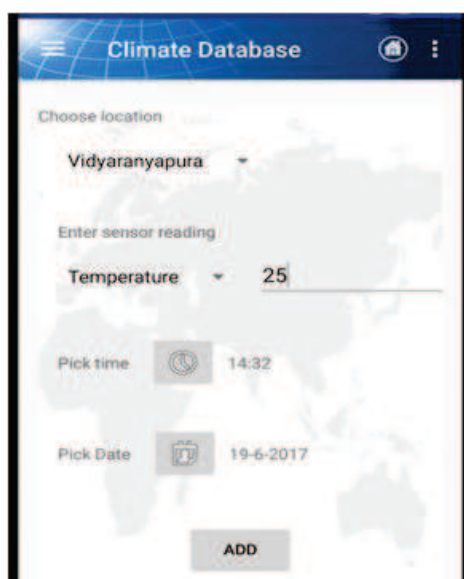

Fig. 5 Navigation Menu of Climate Database

The 3rd option is Climate Database wherein Data entry is achieved manually (Figure 5) and automatically. The former involves adding a new observatory via selecting the location, date, time and ambient air temperature value. The latter involves importing of pre-collected data points in the format of CSV into the database.

Under the next major option of Global Warming Analysis; the Chart viewer helps users to visually and statistically compare the variation of air temperature trend across multiple stations of user choice.
It is a 2-step flow wherein the first screen necessitates confirm/fix the observatories and the time-period for which the data needs to be plotted. The charts are plotted for the duration of either 24 hours, 1 Month or 1 Year from the date of choice. When user clicks on the "View chart" option, the resultant plot and tabulation is separately rendered onto new screens (Figure 6). This is achieved by using a powerful open source 'Android chart view
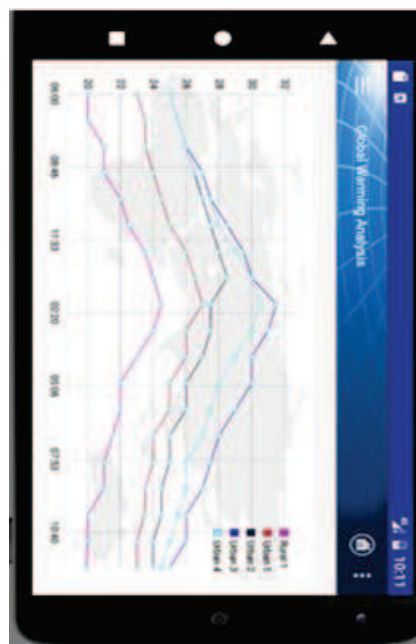

Fig. 6 Sample Resultant Plots for Global Warming Analysis

In the next major option of Urban Warming Analysis; the screen assists users in selection of 1 reference (Rural) station and 1 Urban station. Also the screen provides the option to select time range for the plot. Thereby this screen helps in comparing the temperature trend of a selected urban station against a chosen rural (reference) station.

The plot is again a 2-step flow with the first screen necessitating inputs of each observatory of stations and duration for which the plot is required. Upon selection, the "view chart" option enables user to render the plot & tabulation it in a new screen (Figure 7).
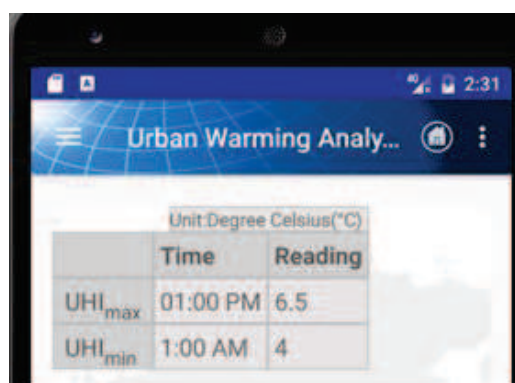

Fig. 7 Sample Resultant Plots for Urban Warming Analysis

About RMA: The computation for urban warming is modelled on R.M.A., which essentially advocates the analysis of 'simultaneous variables' for any form of calculation involving parallel dataset [5]. This is more effective than other existing logics in urban climatology to compute UHI_{max}, UHI_{min} and UHI_{avg}.

The detailed logic of R.M.A. alongside its comparison with other statistical techniques is also presented under the last option as "About App" in main menu. The information is represented with Equations and Charts for reader's convenience. Also under this option, there exists link to YouTube videos for educational material on climate science, and how to use this App.

About App: The version of Clim-App is 1.0 Beta and uses Android studio IDE version 2.1.2.
Built on Android SDK version 6.0 and JDK 1.8; this was tested on emulator device created through Android studio IDE (Figure 8) running on 64 bit Windows 7 Operating System. Finally it was tested on Motorola 2nd Generation smart phone, a cellular device.

Fig. 8 Coding for Clim-App Development

Fig. 9 Data Repository Schema

Data Repository Schema provides the details of out how the climate Data is organized in the database in terms of tables and columns and how they are inter-related through references.

In Clim-App, there exists 3 tables namely Weather Station, Sensor and Reading (Figure 9). This captures the time-zone and GPS coordinates of the location from where climate data is collected. The schema is designed in such a way that it can store data coming from multiple sensors. Along with the reading it captures the unit of data collected and the timestamp at which it was collected.

Future Scope of Development: The App shall be enabled for detecting Automatic Temperature loggers along an additional sensor that can be paired with mobile. Also, to improve the availability of data for benevolence of researchers; the App features will be enhanced to communicate with the central server hosted on a 'cloud' platform.

Conclusion: The demarcation between Urban Warming and Global Warming is quite complex. Inbuilt with 'Relative Magnitude Analysis'; 'Clim-App' assists in error-free real-time forecasting of warming trends and style [5]. Clim-App as a user-friendly, portable, simpler, easier and faster mobile application is perhaps the only cellular software which attempts to clarify between the two types of Warming. Presently ported to Motorola G 2nd generation android phone for device testing and data validation; 'Clim-App" has more precision with respect to actual conditions both quantitatively and qualitatively for the actual magnitude of the 'Urban Heat Island Intensity' (U.H.I.I) favoring in re-design of human comfort. This cellular-tool can assist policy-makers w.r.t. climate sustainable town-planning.

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