Singapore Space & Technology Limited (SSTL) x World Bank Digital Earth Partnership Technology Challenge on Urban Heat

Introduction

The East Asia & Pacific (EAP) region is getting warmer because of climate change. Models predict that mean annual temperatures in the region will increase by 1.0 - 1.7 °C in the medium term (2041-2060) and by up to 3.8 °C in the long term (2081-2100), depending on the climate change scenario. Some parts of the region may see much greater increases. For example, in the worst-case scenario, parts of China could see annual mean temperature increases of 5-6 °C towards the end of this century. In the medium term, Myanmar and Thailand will experience 80-90 days per year with temperatures over 35 °C (~20 more days than in recent years), even in the best-case scenario.[1]

Cities in the region will experience even more extreme temperatures because of the urban heat island (UHI) effect. This effect is caused by several factors. Buildings and paved surfaces absorb more heat during the day than natural surfaces, releasing it at night. Buildings can also obstruct the flow of cooling breezes. Furthermore, cities typically have less vegetation than surrounding rural areas, and, as a result, do not benefit from the shade and the evaporative cooling that vegetation provides. Heat from human sources (including cars, factories, and air conditioners) also raise city temperatures. East Asia's population is already mostly urban, which means that the UHI effect affects the majority of the region's people.

As urbanization and climate change progress, extreme urban heat will become an even more widespread and urgent problem. Studies show that extreme heat increases mortality and illness, reduces economic productivity and educational outcomes, increases energy use for mechanical cooling, and increases crime, violence, and conflict. This has implications for urban prosperity, inclusiveness, and livability.

In response to these challenges, the World Bank, with the support of the Global Facility for Disaster Reduction and Recovery (GFDRR), has initiated the EAP Regional Extreme Urban Heat Study. This study aims to assess the risks of extreme heat exposure across the region and identify ways in which the region's cities can adapt. One component of the study aims to provide better measurement of extreme heat in cities throughout East Asia,[2] as well as to better understand the relationship between a city's urban form and features of its built environment and the strength of the UHI effect. To support this, Singapore Space & Technology Limited (SSTL) is partnering with the World Bank to launch the **Digital Earth Partnership Technology Challenge on**

[1] IPCC WGI Interactive Atlas: Regional synthesis - https://interactive-atlas.ipcc.ch/ (Iturbide et al. 2021. Repository supporting the implementation of FAIR principles in the IPCC-WG1 Atlas. Zenodo, DOI: 10.5281/zenodo.3691645. Available from: https://github.com/IPCC-WG1/Atlas

[2] For the purposes of the study, East Asia is defined as covering Cambodia, China, Indonesia, Korea, Lao PDR, Malaysia, Mongolia, Myanmar, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste and Vietnam.

Urban Heat. The purpose of the challenge is to source remote sensing and other technologies in the space industry to better estimate temperatures and analyse the strength of the UHI effect across the region's cities. This challenge will take advantage of the growing availability of temperature data from thermal infrared sensors mounted on satellites, and crowd-in the best technical expertise in extracting and processing satellite data from the region's space and technology industry. This challenge will be launched at the 2021 Asia Understanding Risk (UR) Forum, which will be held in Singapore and virtually on 2-3 December 2021, and the winner of the challenge will receive the "Digital Earth Partnership Technology Award."

Objectives

The Digital Earth Partnership Technology Challenge on Urban Heat aims to source for firms from the EAP region's space and technology industry to develop proposals for innovative approaches for:

- ***(i)*** the accurate measurement of urban temperatures, including the strength of the UHI effect, for East Asian cities using satellite technology;
- ***(ii)*** the analysis of spatial-temporal patterns of temperature evolution across East Asian cities;
- ***(iii)*** analysis of the correlates of urban temperatures both across East Asian cities and over time, with a focus on the physical features of a city's built environment and urban form; and
- ***(iv)*** more detailed analysis of the evolution of urban temperatures for five East Asian cities - Makassar (Indonesia), Ho Chi Minh City (Vietnam), Manila (Philippines), Phnom Penh (Cambodia) and Vientiane (Lao PDR)), which willinclude ground-truthing work to help verify the satellite-based estimates.

The winning applicant to the challenge will receive the **"Digital Earth Partnership Technology Award,"** and will be responsible for implementing the proposed analysis – which must be fully completed by 8 August 2022 – under the joint supervision of the World Bank and SSTL.

Challenge Statement

1. **An East Asia region wide descriptive analysis of urban temperatures, including the strength of the UHI effect, for East Asian cities using satellite technology,** and

2. **A detailed analysis of urban heat for Makassar (Indonesia), Ho Chi Minh City (Vietnam), Manila (Philippines), Phnom Penh (Cambodia) and Vientiane (Lao PDR).**

Challenge Break Down

For Part 1

a) Construction of a panel data set which provides, for each city, annual, seasonal, & monthly population-weighted estimates[3] of:
   - land surface temperature
   - air temperature / thermal comfort
   - UHI effect

   And which also includes, for each measure, estimates of max and min values, and the number of days for which temperature exceeds (falls below) thresholds.

b) Calculation of measures of variation in both temperature and strength of the UHI effect within each city.
c) Mapping and trend analysis of the evolution of urban temperatures.

For Part 2

a) Development of more detailed maps and analysis of drivers of levels and changes in temperature for each city.
b) Ground-truthing based on, e.g., the vehicle traverse method, stationary monitors, and/or crowd-sourcing.
c) Dynamic exposure modelling (optional), e.g., combining location data from smartphones with data on heat levels to conduct analysis of how exposure might vary throughout a day as people move around a city.

Please note that **not** all challenge deliverables have to be met. Teams/companies are only required to meet the outcomes that are feasible to them given the time and budget and propose how the other deliverables can be achieved.

Submission of Technical Proposal

The technical proposal is the main deliverable from all the participating teams. The technical proposal will be limited to 10 pages and will need to cover how the participating teams plan to tackle the challenge statement, including:

- Overall methodology, assumptions, and limitations (including limitations / gaps of the methodology and data)

- The thermal sensors that it is proposed to use to gather data on surface temperatures from satellites, which would be based on temperatures given off by the land, buildings and other surfaces

- Assessment of the accuracy of publicly available data sets of urban temperatures and the UHI effect and whether they can be used as part of the analysis

[3] For a given city, a population weighted average of temperature can be calculated by weighting temperature for each location in the city by the share of the location's population in the overall population of the city.

- Methods to be used to calculate the strength of the UHI effect

- Methods of mapping and analyzing the derived urban temperature and UHI data to be employed

- Plans for ground-truthing based on, e.g., vehicle traverse method, stationary monitors, and crowd-sourcing

- Plans for dynamic exposure modelling (**optional**) – e.g., combining location data from smartphones with data on heat levels to conduct analysis of how exposure might vary throughout a day as people move around a city

- Proposed timeline and key milestones for delivering the final results by 8 August 2022, including details of intermediate outputs

The submission deadline will be **25 Feb 2022.**

Judging Criteria

The technical proposals will be evaluated based on the following criteria:

1. Specificity of proposed data sources and methodology, including, for example, how participants plan to:
    1. acquire and process satellite data;
    2. address gaps in the data, e.g., due to lack of temporal coverage by satellites or cloud cover;
    3. identify rural reference points to estimate the UHI effect;
    4. map land cover to estimate correlations between heat and the built environment/ urban form;
    5. use land surface temperature from satellite data to estimate near-ground thermal comfort level;
    6. define seasons and other variables in a context-appropriate way;
    7. undertake ground-truthing.

2. Methodology on how participants plan to organize, analyze, and present the data to highlight key findings and facilitate policy-relevant discussion.

3. The feasibility and readiness of participants' technology solution and how quickly it can be deployed.

Announcement of Winner

After the submission of proposals, SSTL will work with the World Bank to review and evaluate the technical proposals and to select the winner of the challenge. The winner of the challenge will receive the "Digital Earth Partnership Technology Award.", with prize money of US$18.5K (S$25K),[4] and have the opportunity to present at the 2022 Global Understanding Risk forum. This will provide them with very strong international exposure.

Lastly, the winner will be recognized in the World Bank's flagship EAP Regional Extreme Urban Heat Study, which will be disseminated by the World Bank throughout the region and globally.

More info on the Digital Earth Partnership Technology Challenge can be found here.

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[4] The prize will be paid in two installments: 50% on announcement of the challenge winner, and 50% on full completion of the work.