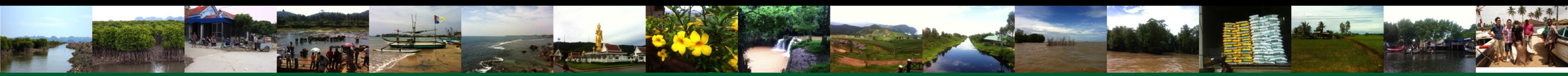

Development of global livability index (GLI) for evaluating global cities

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In this study, three factors were considered to evaluate livability in global cities; "environment", "safety" and "economy". "Environment" consists of air quality and amount of green space, and they are estimated by aerosol optical depth (AOD) and normalized difference vegetation index (NDVI) respectively. "Safety" is composed of natural disaster risks and peace level, and they are estimated by Global Risk Data Platform by UNISDR and the Global Peace Index. "Economy" is represented by economic activity and country development level, and they were estimated by nighttime light exposure from Visible Infrared Imager Radiometer Suite (VIIRS) day/night band and the Human Development Index. These six factors were weighted by least-squares method using 97 cities of training data. The objective variable was set to RepTrak, which is the indicator of reputation of each city based on questionnaire survey by Reputation Institute. The representativeness of training data was confirmed by comparing histogram between cities of training data and all urban areas in the world. As a result, global livability index (GLI) was originally developed and it was found that "safety" was the key factor of livability, whose proportion was 50.2%. GLI enabled cities where questionnaire surveys were not conducted to evaluate livability, and the most livable city in the world was Alta in Norway. By comparing GLI and population density, it was found that the more people were living in the less livable areas. GLI is expected to be used for policy planning by local government.

Introduction

There are some previous studies evaluating livability of global cities. However, since they are based on statistical data, only selected cities can be evaluated in these studies. Therefore, for spatial completeness, remote sensing data was combined with statistical data. The objective of this study is to evaluate livability of cities spatially homogeneously on the global scale by the combination of remote sensing data and statistical data.

Fig. 1 shows the image of this study. An indicator by questionnaire survey in selected cities was spatially extended by combining remote sensing data with statistical data, and Global Livability Index (GLI) was originally developed as a hybrid indicator evaluate global cities.

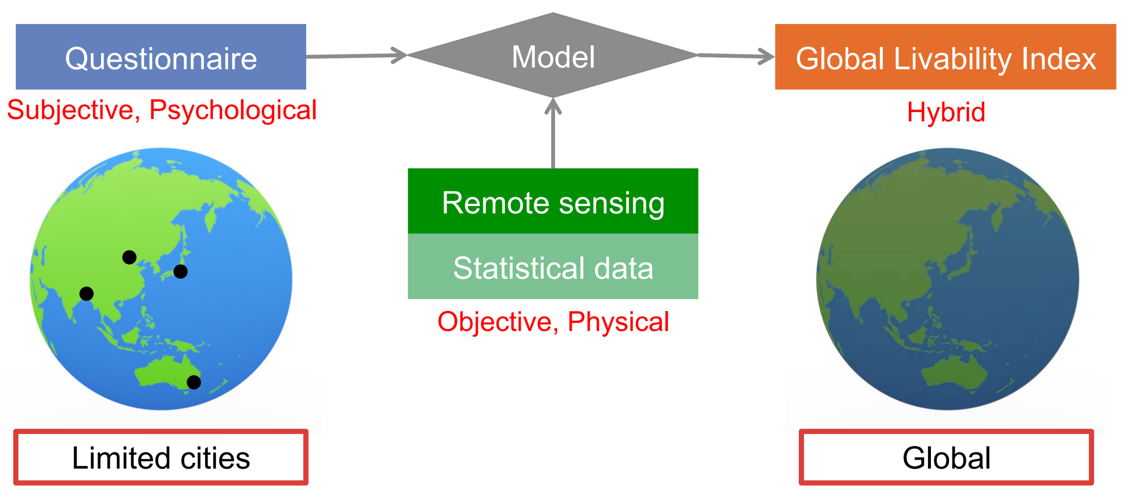

Fig 1. Image of this study

Methodology

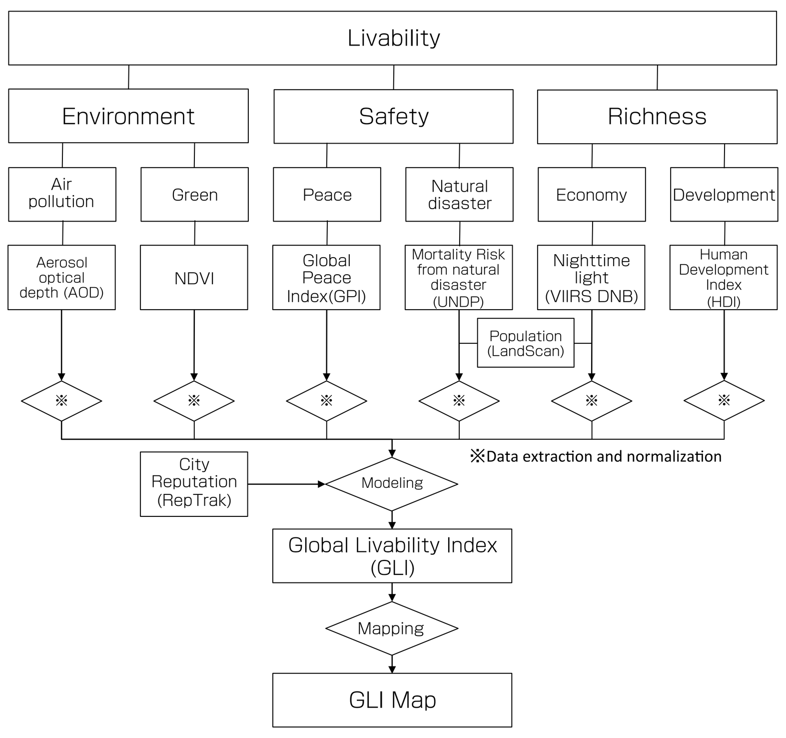

Fig 2. A flowchart of this study

In this study, three factors were considered to evaluate livability; "environment", "safety" and "economy". Each factor is composed of two indicators; air and green for environment, peace and disaster for safety, economy and development for richness. These factors were evaluated by remote sensing data or statistical data. As questionnaire data, RepTrak surveyed by Reputation Institute was used. This ranks world 100 cities based on questionnaire collected by more than 20,000 persons worldwide. Six factors were weighted by least-squares method using 97 cities of training data, and the objective variable was set to RepTrak. Global livability index (GLI) was originally developed in this method, and it was visualized as Figure 3 shows.

Results and Discusstions

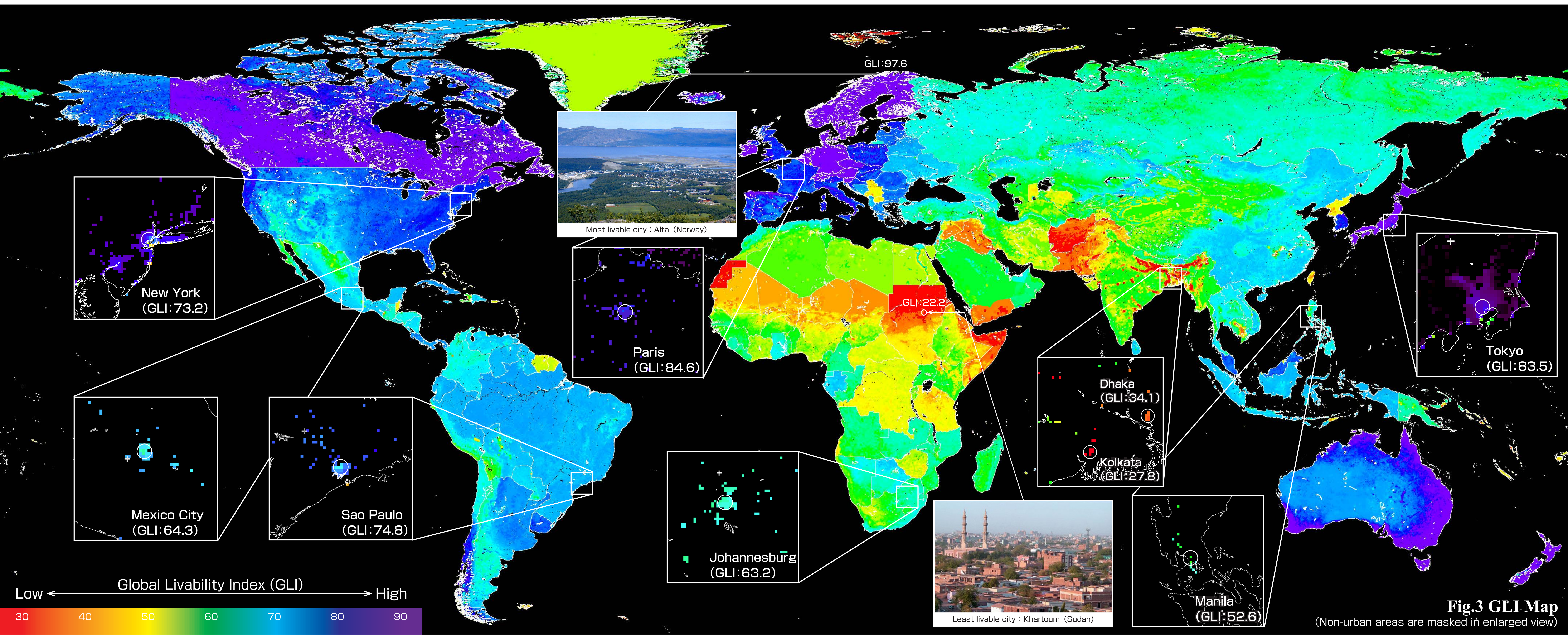

Fig.3 GLI Map
(Non-urban areas are masked in enlarged view)

Figure 4 shows the result of weighting. Among three categories, "safety" accounts for the greatest proportion of livability, which is 50.2%. "Economy" factor in "richness" was absorbed by "development", which is country-specific data.

For verifying the representativeness of 97 cities of training data, histogram of each category was compared between world urban area (about 100km2) and 97 cities of training data. Figure 5 shows comparison of the histograms. As a result, the peak position and shape of these two histograms were closely fit and the representativeness of training data was confirmed.

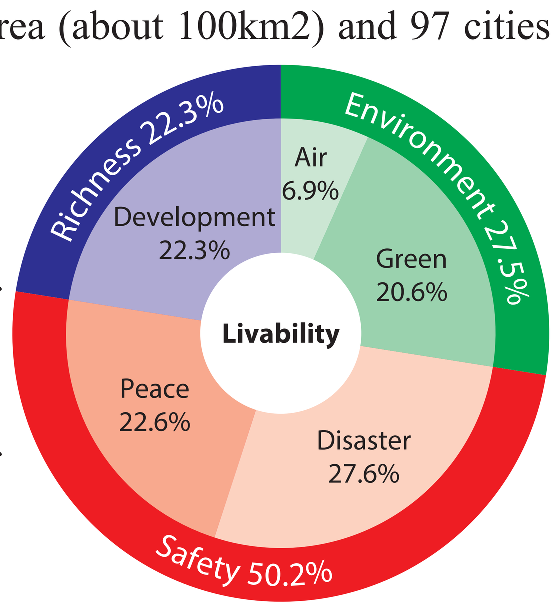

Fig 4. Result of weighting for livability model

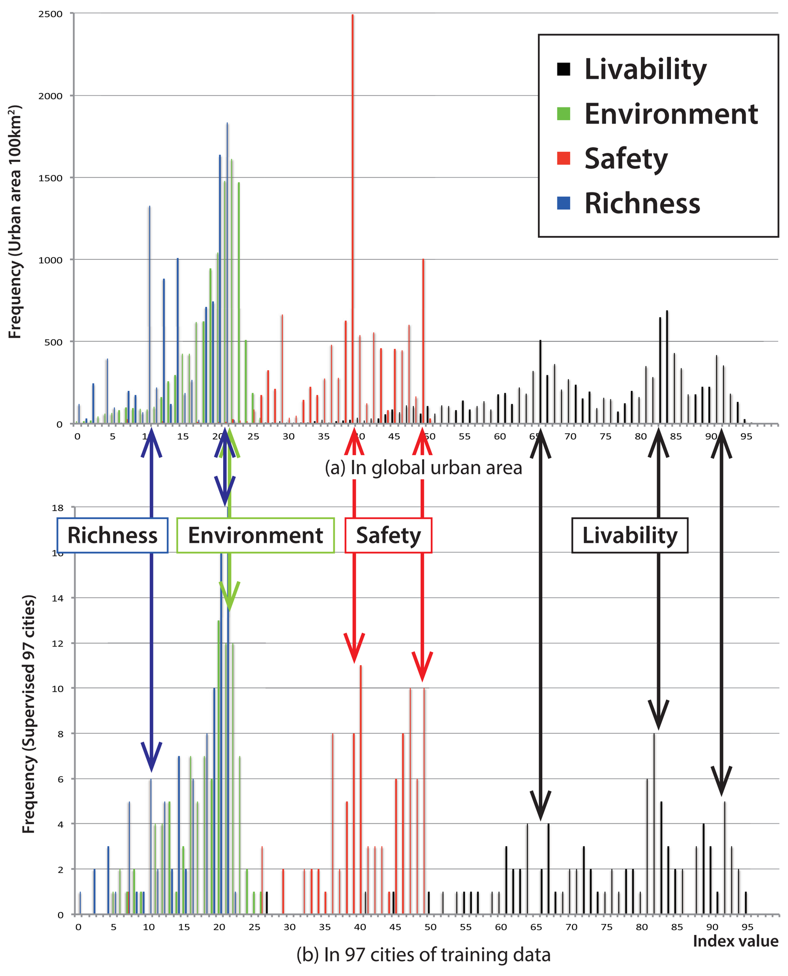

Fig 5. Comparison of histograms of livability and each category.

Conclusion

In this study, questionnaire survey was extended spatially by combining with remote sensing data and statistical data, and global livability index (GLI) was developed for evaluating livability of global urban area. By comparing histogram in cities of training data and that in global urban area, the representativeness of training data was confirmed.

GLI enables cities where questionnaire surveys are not conducted to evaluate livability. According to GLI, world most livable city is Alta in Norway, where GLI is 97.6, and least livable city is Khartoum in Sudan, where GLI is 22.2. In addition, it is easy to evaluate cities continually with this method, and GLI is expected to be used for policy planning by local government.

References

[1] Baugh, Kimberlu, Hsu, Feng Chi, Elvidge, Chris, Zhizhin, Mikhail, 2013. Nighttime Lights Compositing Using the VIIRS Day-Night Band: Preliminary Results, Proceedings of the Asia-Pacific Advanced Network, 35, pp.70-86.
[2] Economist Intelligence Unit: Global Liveability Ranking and Report August 2013, Economist Intelligemce Unit, 2013.
[3] Engel-Cox, Jill A., Holloman, Christopher H., Coutant, Basil W., Hoff, Raymond M., 2004. Qualitative and quantitative evaluation of MODIS satellite sensor data for regional and urban scale air quality, Atomospheric Environment, 38, pp.2495-2509.
[4] Institute for Economics and Peace: Global Peace Index 2013, Institute for Economics and Peace, 2013.
[5] Justice, C.O., Townshend, J.R.G., Vermote, E.F., Masuoka, E., Wolfe R.E., Saleous N., Roy D.P., Morisette J.T., 2002. An overview of MODIS Land data processing and product status, Remote Sensing of Environment, 83(1-2), pp.3-15, 2002.
[6] Levy, R. C., Remer, L. A., Mattoo, S., Vermote, E. F., and Kaufman, Y. J.: Second-generation operational algorithm: retrieval of aerosol properties over land from inversion of Moderate Resolution Imaging Spectroradiometer spectral reflectance, Journal of Geophysical Research, 112, D13211, doi:10.1029/2006JD007811.
[7] Peduzzi, P., Dao, H., Herold, C., Mouton, F., 2009. Assessing global exposure and vulnerability towards natural hazard: the Disaster Risk Index, Natural Hazards and Earth System Sciences, 9, pp.1149-1159.
[8] Reputation Institute: 2013 City RepTrak, Reputation Institute, 2013

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