

Global Trends in Green Area, Public Open Space, and the Human Development Index

Abstract

Public green spaces and public open spaces are increasingly recognized as important components of urban well-being, yet their relationship with national development outcomes remains unclear. This study examines global patterns linking green area per capita, public open space, and the Human Development Index (HDI) from 1990 to 2020. Using trend analysis, choropleth maps, scatterplots, and group-based comparisons, it explores how green space availability varies across development levels. Results show that while HDI consistently increases over time, green area per capita declines across all development groups and shows only a weak cross-national association with HDI. In contrast, public open space demonstrates a clearer relationship with HDI in 2020, highlighting green space access inequality.

Introduction

Public green spaces such as parks, gardens, tree-lined streets, and riverside walkways provide numerous explicit and implicit benefits for urban communities [1]. Citizens increasingly prioritize living environments with a high degree of green integration [1, 2]. Beyond aesthetics, research suggests a positive association between urban green spaces and human well-being, even if not always directly measurable. Identified pathways include reduced stress, increased physical activity, enhanced social interaction, and protection from environmental stressors and pollutants [2, 3, 4].

However, in rapidly urbanizing cities, green space incorporation is often overlooked [5], posing challenges amid population growth and density. Effective planning can mitigate air and noise pollution, reduce stress, and address climate change through shade, heat reduction, and evaporative cooling [5, 6]. Even public open spaces without strong “green” elements—such as squares and walkable sidewalks—provide social and stress-alleviating benefits, though to a lesser extent [7]. Thus, combining green and general public open spaces is valuable, especially in established cities.

This paper examines how these spaces relate to broader development patterns using the Human Development Index (HDI), a United Nations composite measure of health, education, and income. Although broad, the HDI enables identification of global trends and cross-national variation, making potential correlations with urban space particularly compelling.

Data Analysis

A) Global Trends in Human Development Index

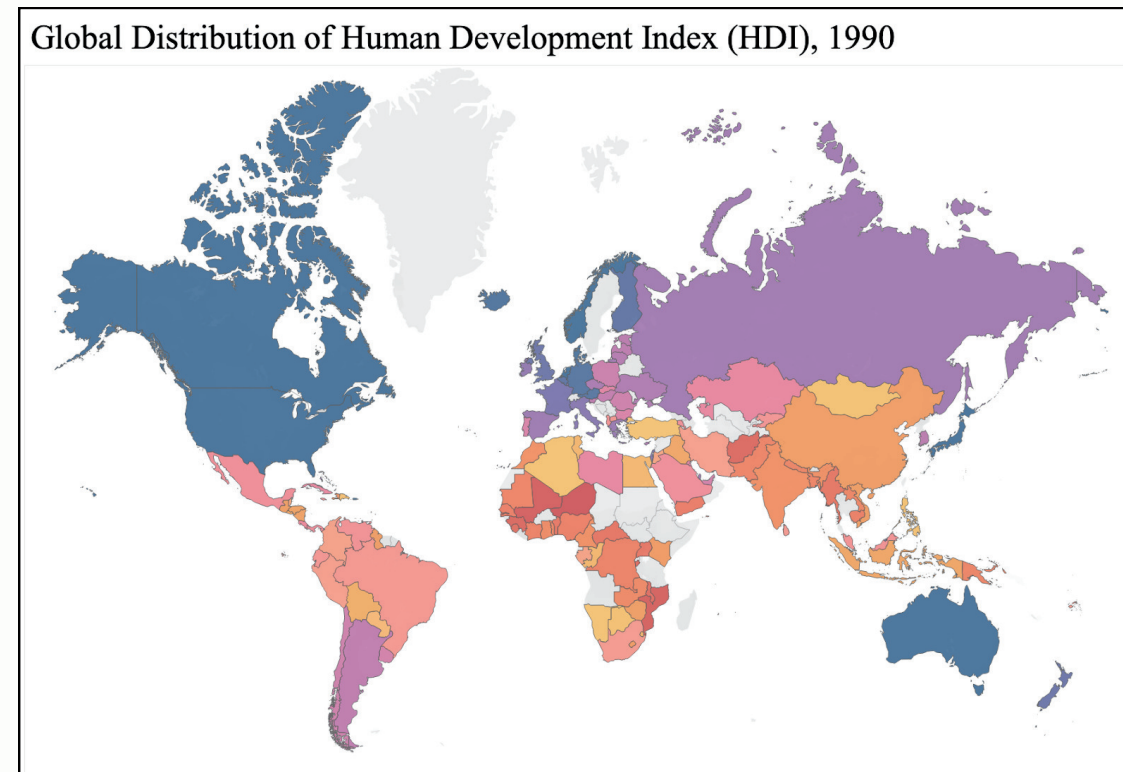


Fig. 1.1. Choropleth map of the global distribution of Human Development Index (HDI) in 1990.

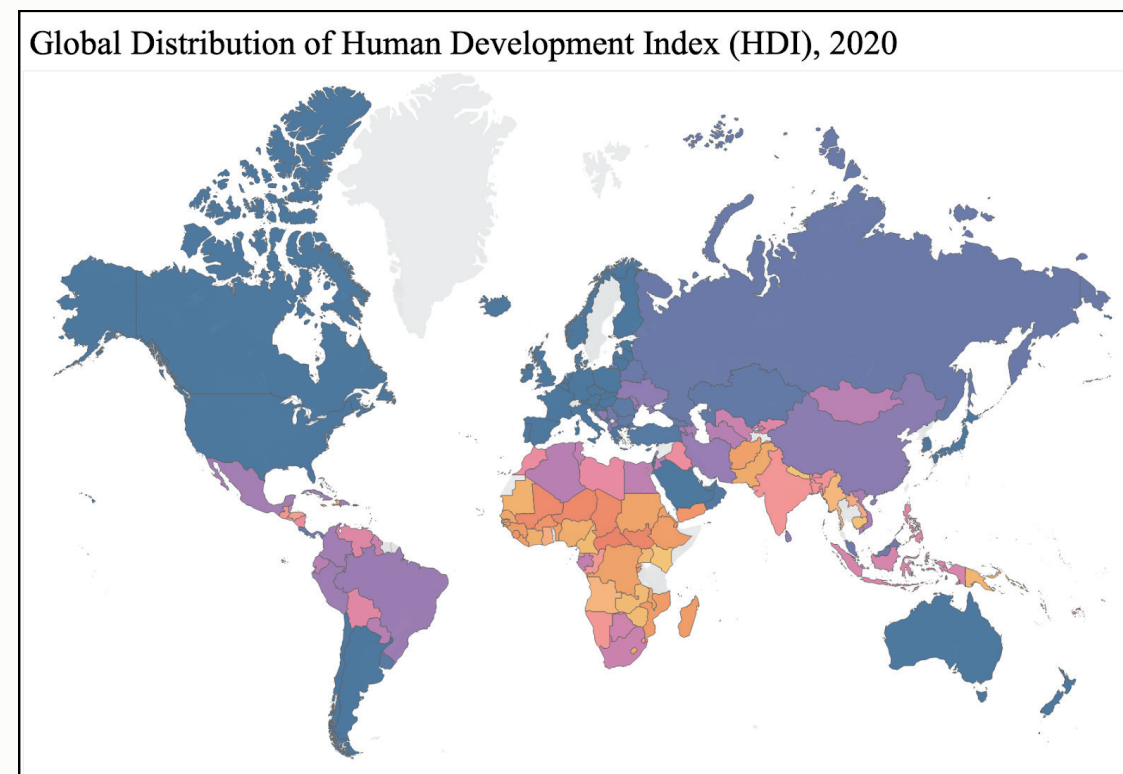


Fig. 1.2. Choropleth map of the global distribution of Human Development Index (HDI) in 2020.

Across all examined maps, clear regional disparities in HDI are visible. In 1990, high HDI levels were concentrated in North America, Western Europe, and Oceania, while Sub-Saharan Africa and South Asia lagged behind. Although most regions show gradual improvement by 2020, areas with initially low HDI remain comparatively lower, indicating limited global convergence over time.

B) Global Trends in Green Area

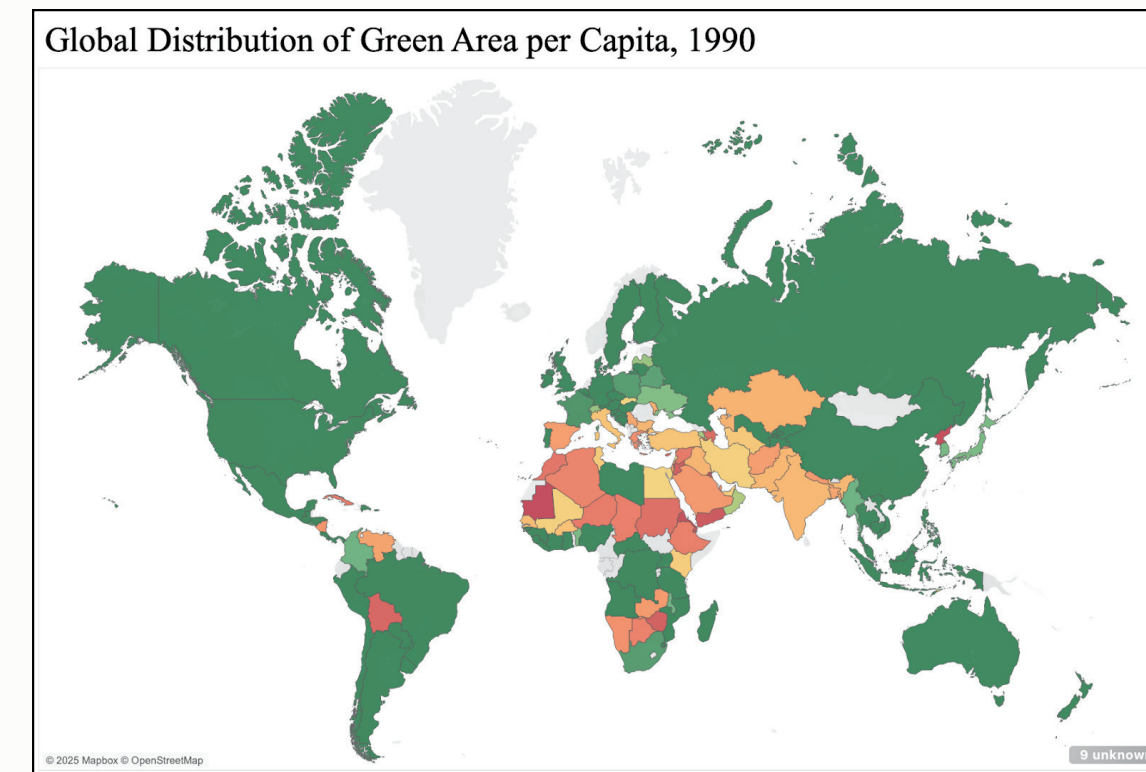


Fig. 2.1. Choropleth map of the global distribution of average green area per capita, in square meters, in 1990.

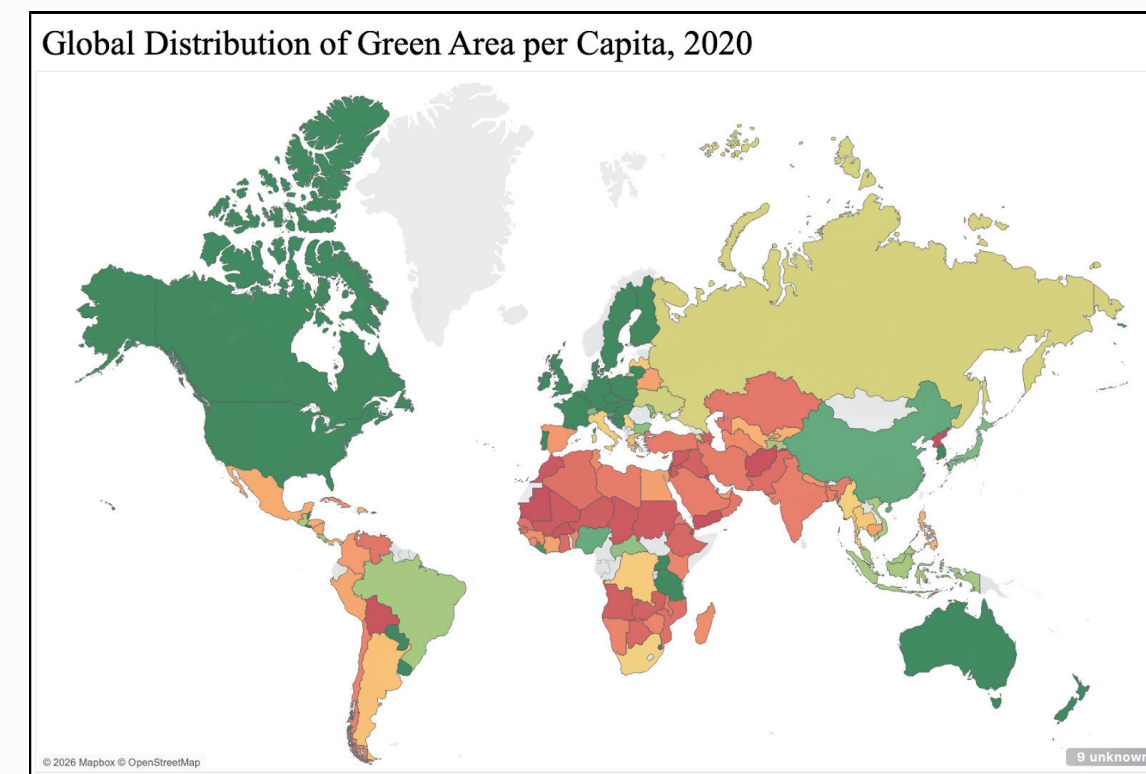


Fig. 2.2. Choropleth map of the global distribution of average green area per capita, in square meters, in 2020.

Across all examined maps, regional differences in green area per capita are clear. North America, Western Europe, and Oceania show consistently higher levels, while South Asia, the Middle East, and Sub-Saharan Africa remain lower. Over time, increasing lighter and red shading suggests a widespread decline, likely linked to rapid population growth and urban expansion.

Data Collection

The data used in this paper were sourced from the United Nations Development Programme [8] and the United Nations Human Settlement Programme [9]. Of the 40 composite measures available, only the Human Development Index (HDI) was utilized, with data extracted for 1990, 2000, 2010, and 2020. Data on average share of green area, green area per capita, and public open space were obtained from the United Nations Human Settlement Programme’s database [9]. All data collection was conducted by the United Nations Human Settlement Programme.

Data Cleaning

Data collected was transformed to be suitable for use in Tableau. Both the original and transformed data are available upon request. For the public open space dataset from the United Nations Settlement Programme [9], no data cleaning was needed. The remaining two datasets required unpivoting.

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Data Analysis (cont.)

C) Cross-National Relationship Between HDI and Green Area

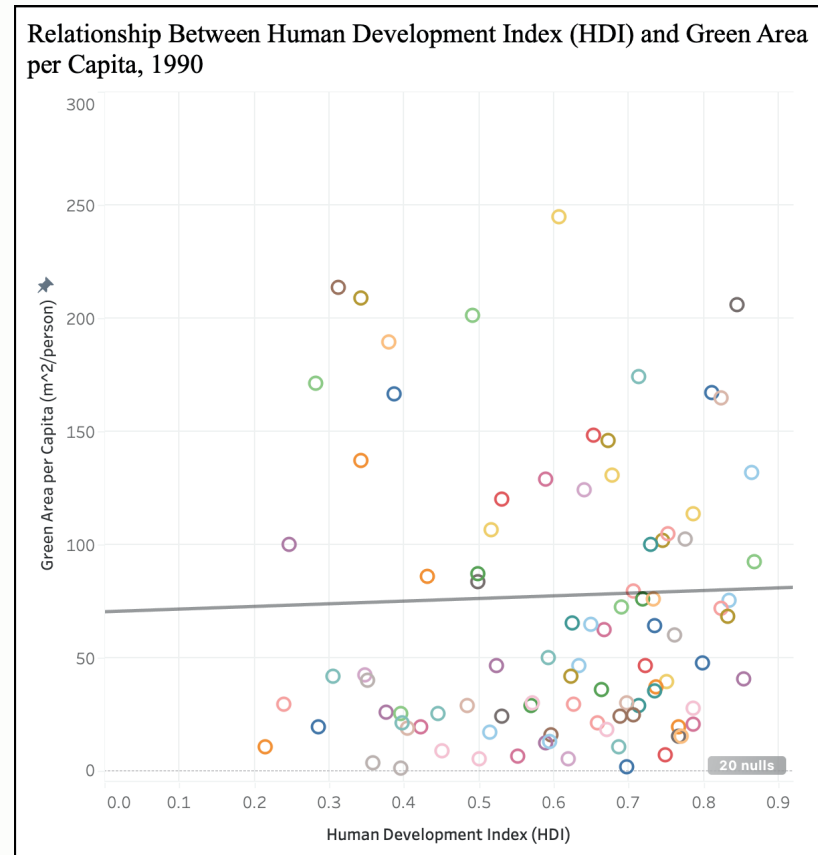


Fig. 3.1. Scatterplot of the relationship between HDI and green area per capita in 1990.

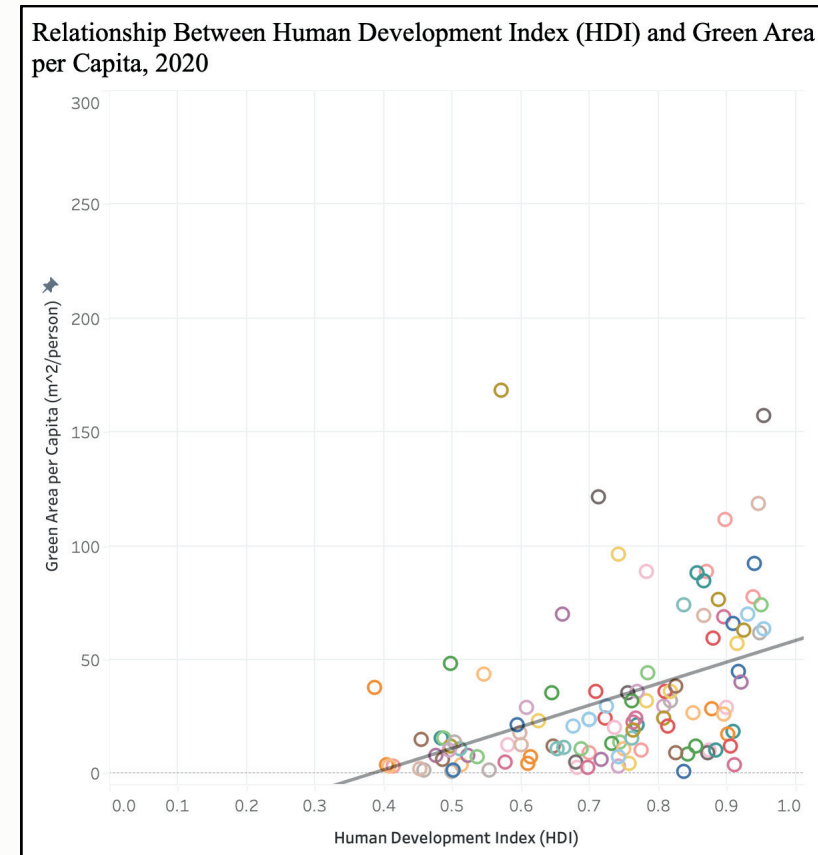


Fig. 3.2. Scatterplot of the relationship between HDI and green area per capita in 2020.

Figures 3.1 and 3.2 are two of four graphs examining the relationship between HDI and green area. Across all years, the relationship is positive but weak, with low R^2 values and wide variation among countries at similar HDI levels. While not statistically significant in 1990, the association becomes marginally significant in 2000 and significant by 2010 and 2020, indicating a more consistent trend over time. However, HDI explains only a small portion of variation, as green space is shaped by factors such as land area, population density, and urban form. Overall, higher development does not consistently correspond to greater green area per capita.

D) HDI Trends by Initial (1990) Development Index

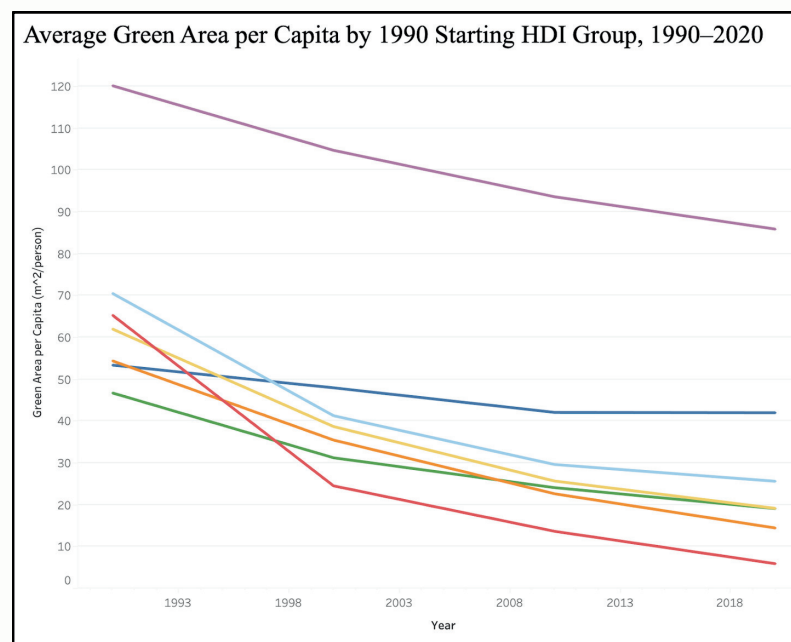


Fig. 6.1. The average green area per capita by 1990 HDI groups, from 1990 to 2020.

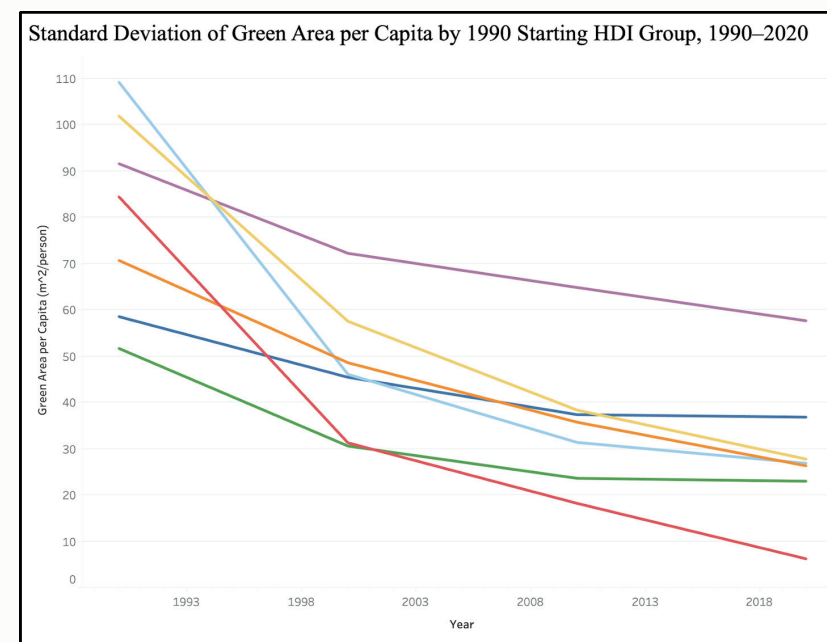


Fig. 7.1. Standard deviation of average green area per capita by 1990 HDI groups, from 1990 to 2020.

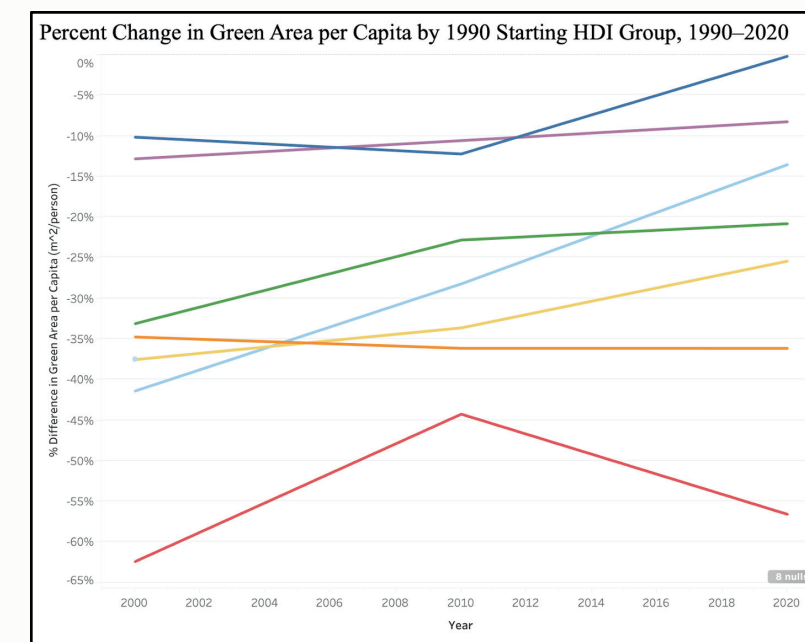


Fig. 3.1. Percent change of average green area per capita by 1990 HDI groups, from 1990 to 2020.

Figure 13.1 shows that green area per capita declines across all Human Development Index groups over time, regardless of initial development level, likely reflecting urbanization and population growth. Higher-HDI countries consistently maintain greater green space, though all groups experience reductions. While group differences are less distinct early on, by 2020 patterns align more closely with HDI levels, though overlaps indicate HDI alone does not determine outcomes. Figure 14.1 shows decreasing standard deviation within groups, suggesting countries with similar starting HDI levels become more alike in green area per capita over time. However, this convergence may reflect shared pressures reducing green space rather than true equality. Figure 15.1 highlights that lower-HDI countries experience larger percentage declines, indicating greater vulnerability to green space loss, while higher-HDI countries show smaller relative decreases despite higher absolute levels. Overall, green area per capita declines across all groups, with development influencing but not fully explaining outcomes. This motivates a shift toward examining public open space as a potentially more flexible alternative for supporting well-being.

D) HDI Trends by Initial (1990) Development Index

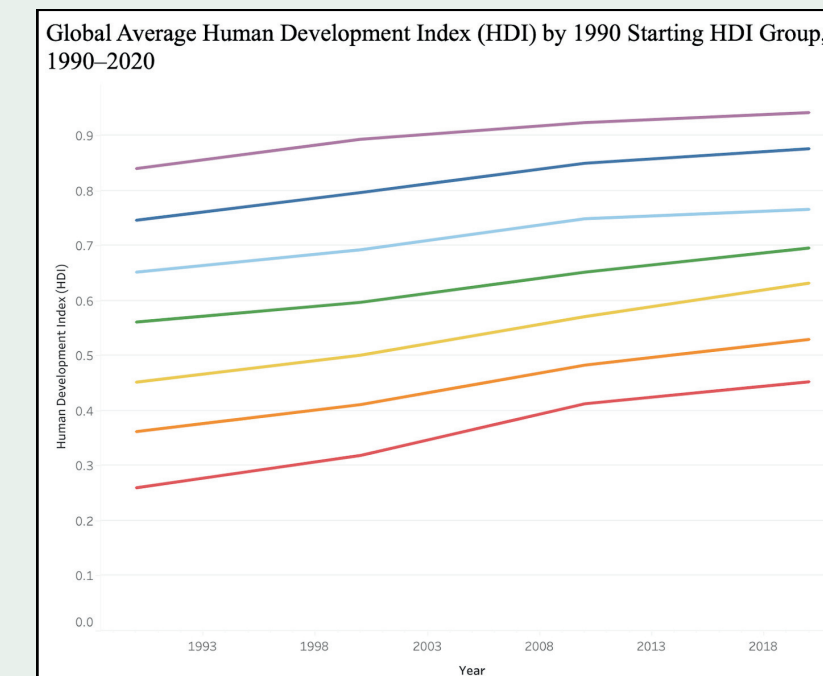


Fig. 4.1. The trend of global HDI over time, in 1990 HDI starting groups.

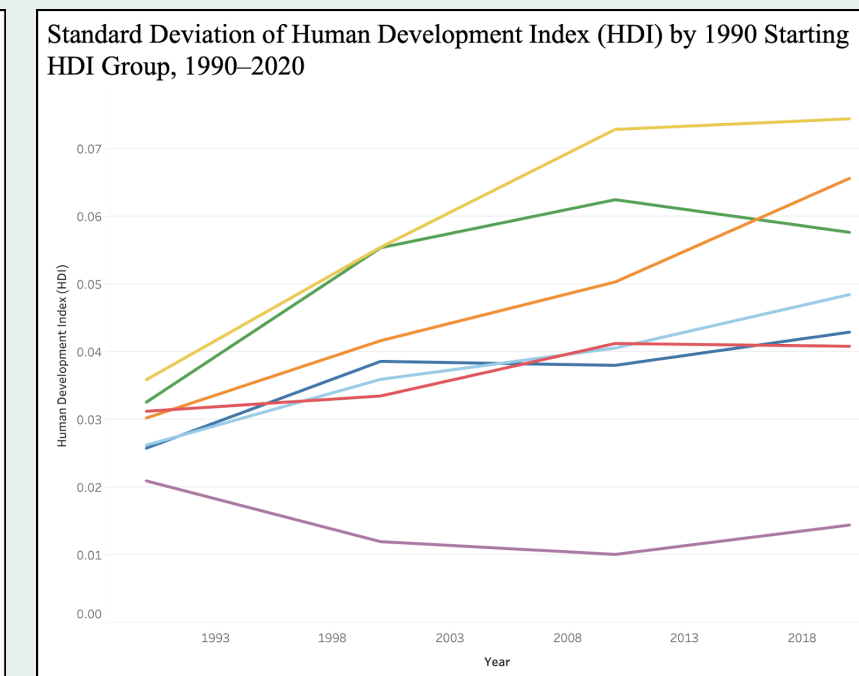


Fig. 5.1. The standard deviation of global HDI over time in 1990 HDI starting groups.

Figure 4.1 shows average Human Development Index trajectories by countries' initial 1990 levels. All groups improve over time, but their relative rankings remain largely unchanged, indicating limited convergence. Lower-HDI groups grow faster but do not close the gap with higher-HDI countries, suggesting lasting effects of initial conditions. Figure 5.1 shows rising standard deviation within most groups, indicating increasing divergence. This is most pronounced in mid-range HDI countries (0.4–0.5), where development paths vary widely. In contrast, high-HDI countries (0.8–0.9) show stable, low variation, reflecting more consistent and institutionally stable development trajectories.

Discussion & Limitations

This paper examined global patterns linking the Human Development Index, green area per capita, and public open space. The analysis found that while HDI improved steadily worldwide, green area per capita consistently declined. Although maps suggested a strong overlap between higher development and greater green space, scatterplot analysis revealed only a weak correlation, indicating that HDI alone does not determine green space outcomes. Factors such as population growth, density, and urban expansion likely play significant roles.

Group-based analysis showed that countries largely maintain their relative development positions, with mid-development countries exhibiting more variation. Green area trends increasingly align with HDI groupings over time, but substantial differences remain. In contrast, public open space shows a clearer relationship with HDI, suggesting it may be a more adaptable form of urban space, particularly in dense or rapidly developing contexts.

Overall, the study provides an exploratory global perspective but does not establish causality. Limitations include limited time points and reliance on national-level data. Future research could incorporate city-level analysis and additional variables to better understand how urban spaces support human development.

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