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## The Spatial Distribution of Population and Its Relationship to Sustainable Development: A Theoretical Study

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**Abstract** :Population is recognized as one of the central topics in human geography. Populations should not be understood merely as statistical figures; they are a powerful force that influences the spatial, economic and social structure of society. There is no uniformity in the way population is distributed over the surface of the earth. Rather, there are differences in the quantity of population distribution and variations in the quality of that distribution. Each region has different natural and human qualities affecting population distribution. These differences may create problems resulting from pressure on resources and at the same time provide opportunities for investment and development elsewhere in the world and in under-populated areas. In the more recent decades, the increasing awareness of issues related to environmental and economic development has promoted the concept of sustainable development as an important theoretical and practical concept that considers how we can accommodate the current "needs" of society, as an exercise to provide "rights" to future generations. This leads to the central question: How much does the spatial distribution of population affect sustainable development pathways? Is unevenness in spatial distribution an impediment to comprehensive development, or can it be translated into an opportunity with proper planning? The significance of this research lies in clarifying the theoretical relationship between spatial population distribution and sustainable development, by analyzing their basic concepts, reviewing the influencing factors, and proposing mechanisms that may contribute to achieving population balance and equitable development.

**Keywords:** Spatial Population Distribution, Sustainable Development, Human Geography, Resource Management, Population Balance.

التوزيع المكاني للسكان وعلاقته بالتنمية المستدامة: دراسة نظرية

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المستخلص:

يُعد السكان أحد الموضوعات الرئيسية في الجغرافية البشرية، إذ لا ينبغي فهم السكان بوصفهم مجرد أرقام إحصائية، بل يمثلون قوة مؤثرة في البنية المكانية والاقتصادية والاجتماعية للمجتمع. ولا يوجد تجانس في

طريقة توزيع السكان على سطح الأرض، بل هناك اختلافات في حجم التوزيع السكاني وتباينات في نوعية هذا التوزيع. وتمتلك كل منطقة خصائص طبيعية وبشرية مختلفة تؤثر في توزيع السكان. وقد تؤدي هذه الاختلافات إلى ظهور مشكلات ناتجة عن الضغط على الموارد، وفي الوقت نفسه توفر فرصًا للاستثمار والتنمية في مناطق أخرى من العالم وفي المناطق قليلة السكان.

وفي العقود الأخيرة، أدى تزايد الوعي بالقضايا المتعلقة بالتنمية البيئية والاقتصادية إلى تعزيز مفهوم التنمية المستدامة بوصفه مفهومًا نظريًا وعمليًا مهمًا، يهتم بكيفية تلبية "احتياجات" المجتمع الحالية مع ضمان "حقوق" الأجيال القادمة. ومن هنا يبرز التساؤل الرئيس: إلى أي مدى يؤثر التوزيع المكاني للسكان في مسارات التنمية المستدامة؟ وهل يُعد عدم التوازن في التوزيع المكاني عائقًا أمام التنمية الشاملة، أم يمكن تحويله إلى فرصة من خلال التخطيط السليم؟

وتتمن أهمية هذا البحث في توضيح العلاقة النظرية بين التوزيع المكاني للسكان والتنمية المستدامة، من خلال تحليل مفاهيمها الأساسية، واستعراض العوامل المؤثرة فيهما، واقتراح آليات يمكن أن تسهم في تحقيق التوازن السكاني والتنمية العادلة.

*الكلمات المفتاحية:* التوزيع المكاني للسكان، التنمية المستدامة، الجغرافية البشرية، إدارة الموارد، التوازن السكاني.

## 1. INTRODUCTION

### 1.1 Background

The enduring and complex question concerning the spatial distribution of populations has persisted as a fundamental concern in both human geography and development studies (Franklin, 2023; Horner, 2020; Kalantar et al., 2020). An unfair and inequitable distribution of people exemplifies an unfair and inequitable distribution of natural or human processes such as climate, landscape, allure as a factor for economic opportunities, flows of infrastructure and many others (Ali, 2025; Hendricks & Van Zandt, 2021; Schultz, 2020). Unsuccessful interventions in a beginning condition will condition every subsequent process of planning for future and regional development and sustainability of the environment as a spatially distinct problem (Christmann et al., 2020; Schindler & Kanai, 2021). Globally to a globally connecting and urbanizing world there is an increasing awareness about the dichotomy of unequal population density alongside an uneven distribution of the meaningful developmental resources in an increasingly crowded urban world (McFarlane, 2020). Adding to this is an expectation of sustainable development that is conditioning the development that asks to balance our developmental interaction with some measurable intent for protecting social equity and environmental protection (Clark & Harley, 2020;

Edwards, 2021). If educators and researchers want to focus on the development of an equitable social base, equitable access to developmental opportunities, when pressing the theorization of the relational connection between the population distribution and its spatial characteristics to its sustainable development context, it will be in developing some balance of consumption and production so we can move into a sustainable relationship for a continuous equal access to developmental opportunities for present and future generations (Ramirez & Lizarazo, 2025; Zeng & Zong, 2023).

### **1.2 Research Problem**

Population distribution across geographic space is characterized by imbalance, as large numbers concentrate in major cities while vast areas remain sparsely populated (Le Tourneau, 2020; Razooqi, 2020). This leads to urban and environmental problems on the one hand, and weak utilization of resources in peripheral regions on the other. This imbalance raises a central research question: How can the spatial distribution of population influence the trajectories of sustainable development?

### **1.3 Research Objectives**

1. To clarify the concept of spatial population distribution and its influencing factors.
2. To analyze the concept of sustainable development and its dimensions.
3. To examine the theoretical relationship between population distribution and sustainable development.
4. To review theoretical mechanisms for achieving alignment between the two.

### **1.4 Research Hypothesis**

This study hypothesizes that a balanced spatial distribution of population is a fundamental prerequisite for achieving equitable sustainable development, while an imbalanced distribution results in economic, social, and environmental distortions.

### **1.5 Research Methodology**

The research adopts a descriptive–analytical approach, relying on theoretical information collected from scientific sources and international documents, followed by critical analysis to reach theoretical conclusions relevant to the subject.

## **2. THEORETICAL FRAMEWORK OF POPULATION GEOGRAPHY**

### **2.1 The Concept of Population Geography**

Population geography is a branch of human geography concerned with studying the geographical distribution of population in terms of size, density, structure, and migration (Zhao et al., 2025). It goes beyond numerical representation, emphasizing the analysis of the relationship between population and their surrounding environment, and how people both influence and are influenced by place (Lewis & Buffel, 2020).

### **2.2 Evolution of Population Thought in Geographical Studies**

- Descriptive Phase: Early studies focused on describing areas of population concentration without providing explanations.
- Explanatory Phase: The emergence of theories linking population distribution to natural factors such as climate and soil, most notably the theory of environmental determinism.
- Modern Phase: Attention shifted toward the interaction between natural and human factors, with growing emphasis on economic, political, and cultural influences.

### **2.3 Approaches to the Study of Population**

- Statistical Approach: Relies on numerical data such as censuses and surveys.
- Demographic Approach: Focuses on population characteristics such as age, gender, and economic structure.
- Spatial Approach: Analyzes spatial distribution and spatial changes in population size and density.

### **2.4 Importance of Studying Population Geography**

- Supports regional planning and guides the allocation of investments.
- Identify areas of population pressure and developmental gaps.

- Enhances understanding of the relationship between population, resources, and the environment.

### **3. SPATIAL DISTRIBUTION OF POPULATION**

#### **3.1 Concept of Spatial Population Distribution**

The spatial distribution of population refers to the manner in which people are spread across the earth's surface within a specific area, whether at the global, national, regional, or city level (Benz & Burney, 2021). It illustrates the degree of variation in population density between regions, where some areas are heavily congested while others are nearly empty (Chang et al., 2021). The concept extends beyond quantitative aspects (population size) to include qualitative characteristics such as age, gender, and economic structure (Muttarak, 2021). This concept is central to population studies, as it represents the starting point for any analysis linking population with resources, economic activities, and development (Ruggerio, 2021).

#### **3.2 Characteristics of Spatial Population Distribution**

- **Spatial Variation:** Clear disparities exist between densely populated regions (major cities) and sparsely populated regions (deserts and mountains).
- **Dynamic Nature:** Distribution is not fixed but changes over time due to migration, economic development, or natural disasters.
- **Spatial Gradient:** Population density tends to concentrate around major urban centers and gradually declines with distance.
- **Resource Dependence:** Populations cluster in areas with abundant water resources, fertile lands, and employment opportunities.

#### **3.3 Indicators for Measuring Spatial Population Distribution**

Several indicators are commonly used to measure population distribution (Man et al., 2021), including:

General Population Density:  $\text{Population Size} \div \text{Land Area (persons/km}^2\text{)}$

Physiological Density:  $\text{Population Size} \div \text{Arable Land Area}$

Economic Density:  $\text{Population Size} \div$

Value of Economic Output or Employment Opportunities

Urban Concentration Ratio:  $\text{Urban Population} \div \text{Total Population}$

These indicators help researchers understand the relationship between population and space, and to identify areas of population pressure or vulnerability.

### **3.4 Factors Influencing Spatial Population Distribution**

#### **3.4.1 Natural Factors**

- Climate: Moderate climates attract higher population densities, while deserts and polar regions are sparsely populated.
- Relief: Plains and flatlands are more attractive than mountainous or rugged areas.
- Water Resources: Rivers, lakes, and groundwater sources are key elements of population concentration (e.g., the Nile Valley).
- Soil: Fertile agricultural land supports high population densities.

#### **3.4.2 Economic Factors**

- Availability of employment opportunities in industry and services.
- Presence of ports, airports, and commercial centers.
- Large-scale investments and urban development projects.

#### **3.4.3 Social and Political Factors**

- Political and security stability attracts and retains population.
- Cultural values and traditions may influence settlement patterns (e.g., tribal or clan-based clustering).
- Government policies (land distribution, agricultural support, establishment of new towns).

#### **3.4.4 Historical Factors**

- Ancient migration and trade routes played a role in the emergence of cities and urban centers.
- Wars and conflicts often result in displacement or redistribution of population.

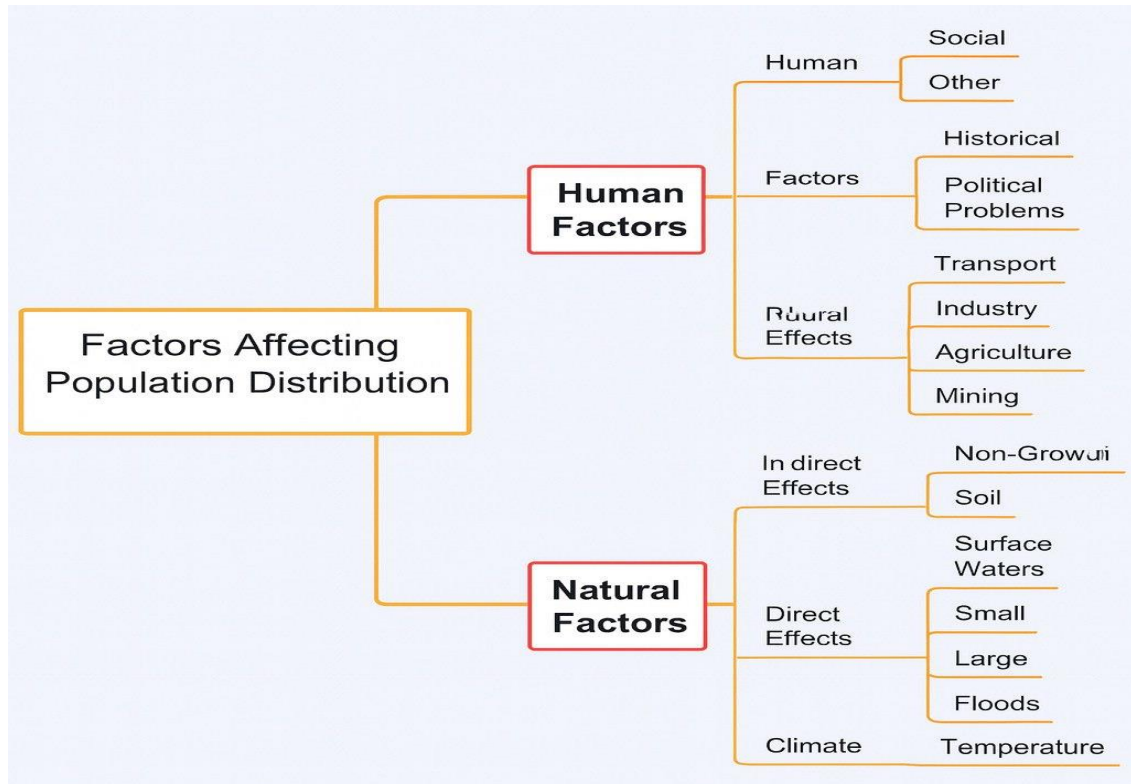


Figure 1. Factors Influencing Population Distribution (Al-Desouki, 2024).

### 3.5 Global Patterns of Spatial Population Distribution

- High-Density Areas: East Asia (China, India, Japan), Western Europe, and the Nile Valley.
- Moderate-Density Areas: Most of South America and parts of Africa.
- Sparsely Populated Areas: Major deserts (Sahara, Empty Quarter), polar regions, and dense tropical rainforests.

### 3.6 Illustrative Examples of Spatial Variation in Distribution

- Egypt: Over 95% of the population is concentrated in a narrow strip along the Nile and its delta, while the desert covers most of the land area.
- China: Despite its vast size, most of the population is concentrated in the eastern coastal provinces.
- Iraq: High density is observed in the alluvial plains (Baghdad, Basra, Mosul), while the mountainous and desert areas remain sparsely populated.

### 3.7 Importance of Studying Spatial Population Distribution

- Supports regional planning and investment allocation.
- Identifies areas of population pressure that require mitigation policies.
- Clarifies the relationship between population and natural resources.
- Provides the foundation for understanding and achieving sustainable development.

## **4. SUSTAINABLE DEVELOPMENT – CONCEPT AND DIMENSIONS**

### **4.1 Concept of Sustainable Development**

The term sustainable development was formally introduced in the 1987 report of the Brundtland Commission titled “Our Common Future”. It was defined as:

“Development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.”

This definition reflects the required balance between economic and social development on the one hand, and environmental and resource conservation on the other. Hence, sustainable development is not merely an economic process, but a comprehensive vision that integrates economic, social, environmental, and political dimensions.

### **4.2 Historical Evolution of the Concept of Sustainable Development**

- 1950s–1960s: Focused on economic growth as the sole indicator of progress.
- 1970s: Environmental issues emerged after UN conferences, particularly the Stockholm Conference (1972).
- 1980s: The concept of sustainable development appeared through international reports (Brundtland Report, 1987).
- 1990s: The Earth Summit in Rio de Janeiro (1992) institutionalized the concept at the global level.
- 2000s and beyond: Formulation of the Millennium Development Goals (2000–2015) followed by the Sustainable Development Goals (SDGs) (2015–2030).

### **4.3 Core Dimensions of Sustainable Development**

#### **4.3.1 Economic Dimension**

- Improving efficiency in resource utilization.
- Diversifying income sources and reducing reliance on a single sector.
- Providing employment opportunities to absorb unemployment and achieve economic equity.
- Encouraging innovation and environmentally friendly technologies.

#### **4.3.2 Social Dimension**

- Reducing inequalities among social classes.
- Promoting justice and equal opportunities.
- Improving health and education services.
- Strengthening community participation and good governance.

#### **4.3.3 Environmental Dimension**

- Conserving natural resources (water, soil, forests).
- Reducing environmental pollution and carbon emissions.
- Expanding the use of renewable energies (solar, wind).
- Protecting biodiversity.

#### **4.4 Sustainable Development Goals (SDGs 2030)**

- The United Nations has outlined 17 Sustainable Development Goals, including:
- No poverty.
- Zero hunger.
- Good health and well-being.
- Quality education.
- Gender equality.
- Clean water and sanitation.
- Affordable and clean energy.
- Decent work and economic growth.
- Industry, innovation, and infrastructure.
- Reduced inequalities.
- Sustainable cities and communities.
- Responsible consumption and production.
- Climate action.

- Life below water.
- Life on land.
- Peace, justice, and strong institutions.
- Partnerships for the goals.



Figure 2. Sustainable Development Goals. Source: University of Kufa

#### 4.5 Challenges Facing Sustainable Development

- a) Rapid Population Growth: Increasing population puts pressure on resources and services.
- b) Unequal Distribution of Resources: Disparities between urban and rural areas, and between developed and developing countries.
- c) Climate Change: Rising temperatures, melting ice, and desertification.
- d) Conflicts and Wars: Destruction of infrastructure and disruption of development pathways.
- e) Weak Social Awareness: Lack of sustainability culture among individuals and institutions.

#### 4.6 Importance of Sustainable Development in Population Studies

- Provides a framework linking population growth with resource management.
- Highlights the need to balance population density with the environmental carrying capacity.
- Considers spatial distribution of population as part of social equity.
- Integrates population planning into long-term development objectives.

## Understanding Population Density and Its Importance



Figure 3. Understanding population density and its importance (fastercapital, 2025).

## 5. THE RELATIONSHIP BETWEEN POPULATION DISTRIBUTION AND SUSTAINABLE DEVELOPMENT

### 5.1 Unbalanced Distribution as an Obstacle to Sustainable Development

An uneven spatial distribution of population is one of the most significant challenges to development efforts. The concentration of large populations in major cities, contrasted with depopulated rural and peripheral regions, results in:

- Severe pressure on basic services (health, education, transport).
- Housing crises and the emergence of informal settlements.

- Environmental pollution and increased waste generation.
- Rising urban unemployment and poverty.

Meanwhile, sparsely populated areas often remain underutilized despite possessing natural resources that could support national economic growth.

## 5.2 Impact of Urban Concentration on the Environment and Development

Large metropolitan areas such as Cairo, Baghdad, New Delhi, and Mexico City suffer from:

- Severe traffic congestion that reduces productivity.
- Air and water pollution caused by industrial emissions.
- Excessive energy consumption and rising carbon emissions.
- Degradation of agricultural land due to unplanned urban expansion.

These issues not only hinder development but also threaten the three dimensions of sustainability (economic, social, and environmental).

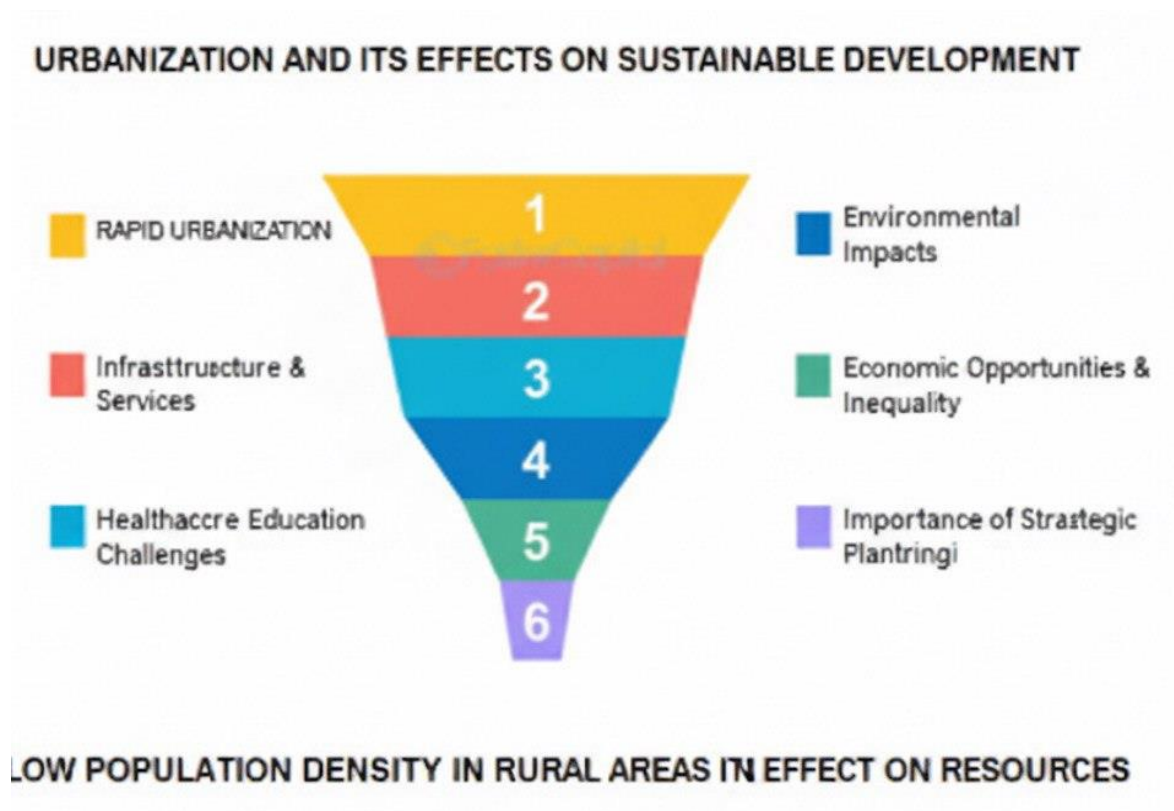


Figure 4. Urbanization and its impact on sustainable development.

## 5.3 Low Population Density in Rural Areas and Its Impact on Resources

In contrast to urban concentration, rural or peripheral regions face low population densities, which leads to:

- Shortages of agricultural and industrial labor.
- Neglect of farmland and reduced production.
- Slow progress in local development.
- Continuous population drain due to internal migration toward cities.

This situation creates a widening gap between rural and urban areas, resulting in developmental imbalances that negatively affect the national scale.

#### **5.4 Internal Migration and Its Role in Reshaping Population Distribution**

Internal migration, especially rural-to-urban flows, is one of the key drivers of spatial population change. It contributes to:

- Increased pressure on large cities.
- Depopulation of rural areas and loss of young labor forces.
- Restructuring of demographics, with higher proportions of youth in cities and declining shares in rural areas.
- Growing disguised unemployment as labor supply exceeds demand in urban labor markets.

#### **5.5 Developmental and Regional Gaps**

Unequal population distribution leads to significant disparities between regions:

- Some regions experience rapid economic growth, while others face marginalization.
- Developmental gaps deepen social inequalities and generate problems such as poverty and forced migration.
- Lack of regional balance weakens progress toward the Sustainable Development Goals (SDGs), particularly those related to justice and equity.

## 5.6 Theoretical Relationship Between Population and Sustainable Development

This relationship can be summarized as follows:

- a) Balanced population distribution promotes efficient resource utilization, enhancing sustainability.
- b) Urban congestion generates environmental and social problems that undermine sustainability.
- c) Rural development reduces rural-to-urban migration and fosters equitable population distribution.
- d) Regional planning serves as a tool to integrate population dynamics with sustainable development strategies.
- e) Spatial equity is a prerequisite for achieving social equity, a principle emphasized by the SDGs.

## 5.7 Practical Examples

- China: Adopted a policy of developing western regions to reduce disparities between the densely populated east and the less populated west.
- Brazil: Established its new inland capital, Brasília, to relieve pressure from Rio de Janeiro and São Paulo.
- Egypt: Built new desert cities (e.g., 6th of October City) to ease the burden on Cairo.

These cases illustrate that spatial population planning is an integral part of sustainable development strategies.

## 6. MECHANISMS FOR ACHIEVING BALANCE BETWEEN POPULATION AND SUSTAINABLE DEVELOPMENT

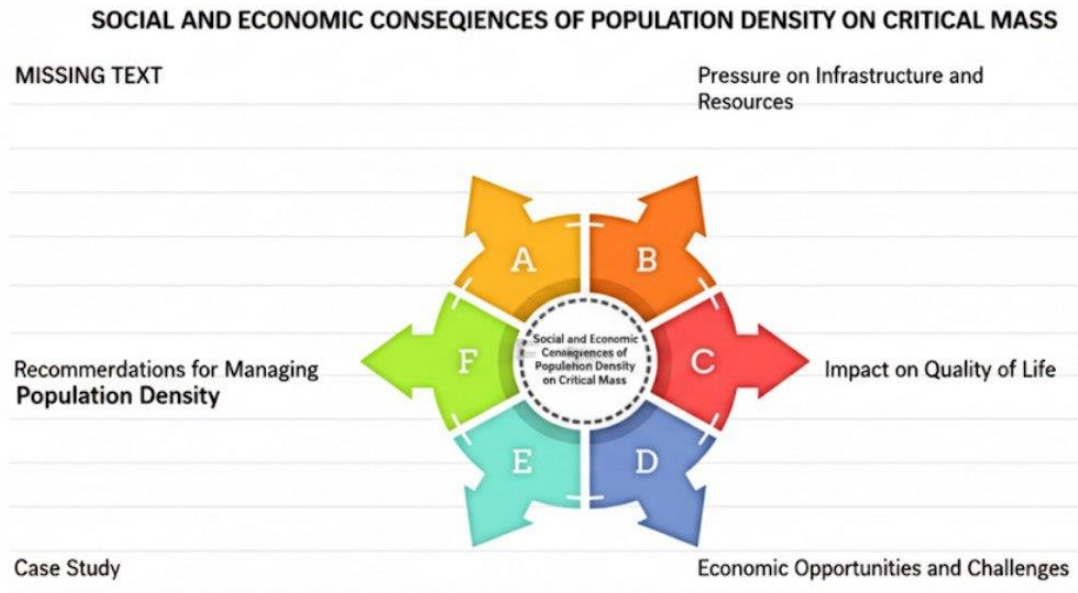
### 6.1 Regional Planning and Population Redistribution

Regional planning is one of the most important tools for achieving demographic and developmental balance. It involves:

- Directing investments toward less-developed regions.
- Establishing new cities to absorb population growth.
- Expanding infrastructure in peripheral areas.

Creating industrial and agricultural zones in sparsely populated regions.

Example: France implemented the *growth poles policy* aimed at distributing economic activities more evenly among regions.



**Figure 5.** Economic and Social Consequences of Population Density on the Critical Mass.

## 6.2 Economic Incentive Policies

Populations can be encouraged to relocate to new areas through:

- Providing stable employment opportunities.
- Offering tax exemptions for investors in low-density regions.
- Supporting small and medium-sized enterprises in rural areas.
- Granting soft loans to households willing to settle in new cities.

Example: China granted major incentives to companies investing in its western provinces, which helped attract population flows.

## 6.3 Development of Infrastructure and Services

Attracting population to peripheral areas requires the provision of basic services, such as:

- Transport networks and roads.
- Safe drinking water and electricity.
- Health centers and hospitals.
- Schools and universities.

In the absence of such services, populations tend to remain in overcrowded major cities.

## 6.4 Rural and Agricultural Development

Rural development plays a crucial role in addressing demographic imbalances by:

- Improving agricultural productivity through modern technology.
- Supporting rural industries (e.g., dairy, textiles, food processing).
- Diversifying rural income sources (eco-tourism, handicrafts).
- Empowering rural women and integrating them into economic activities.

Example: India adopted *Integrated Rural Development Programs* to reduce rural-to-urban migration.

### **6.5 Social Justice as a Pillar of Sustainability**

Achieving social justice entails:

- Reducing disparities in living standards across regions.
- Ensuring equitable distribution of national resources.
- Protecting the rights of marginalized groups.
- Engaging citizens in decision-making through community participation.

Without social justice, development remains incomplete and unsustainable.

### **6.6 The Role of Population Policies**

Well-designed population policies can support sustainable development by:

- Regulating population growth rates in line with available resources.
- Promoting balanced distribution through housing and employment programs.
- Supporting reverse migration toward rural areas.
- Linking development strategies with long-term population plans.

### **6.7 Successful International Experiences**

- a) Malaysia: Adopted policies for developing interior regions and connecting them through modern roads and airports, achieving both demographic and economic balance.
- b) Brazil: Relocated its capital to the interior (Brasília) as part of a broader redistribution strategy.
- c) South Korea: Enhanced rural regions through modern agricultural technologies, reducing migration to Seoul.

- d) Egypt: Built new desert cities such as 10th of Ramadan to relieve pressure on Greater Cairo.

## **6.8 The Role of Civil Society and International Organizations**

- Civil society: Promotes awareness of the importance of balanced population distribution.
- International organizations: Bodies such as the United Nations and the World Bank provide financial and technical assistance to achieve SDGs.
- International partnerships: Knowledge and experience sharing among countries supports the adoption of successful policies.

## **6.9 Future Relationship Between Population Distribution and Sustainability**

- With global population expected to reach about 9.7 billion by 2050, equitable distribution will become even more urgent.
- The transition to smart cities and reliance on advanced technologies may help reduce urban pressures.
- Increasing focus on rural development may provide the most effective solution to bridging regional gaps.



Figure 6. Prospects and sustainability of the Sustainable Development Goals.

## CONCLUSION

Through reviewing the theoretical concepts of population geography and sustainable development and analyzing the relationship between spatial population distribution and sustainability requirements, it becomes clear that population distribution is a decisive factor in the success or failure of development plans. Unbalanced distribution creates immense pressure on major cities while depriving peripheral regions of development opportunities, thereby generating social, economic, and environmental gaps that hinder the achievement of sustainable development goals.

On the other hand, balanced settlement patterns increase efficient use of resources, social equity, and extend potential for systematic and sustainable development. Thus, regional planning, appropriate population policies, rural development, and physical infrastructure expansion are significant tools to reconcile growth with demographic level.

## Findings

1. Population distribution must be seen as more than a demographic phenomenon; it is a key part of sustainable development planning.
2. The uneven population distribution will cause all the urban inflation and the stress on big cities whilst the inner regions decline.
3. Sustainable development will be unobtainable without population policies integrated into economic and social development.
4. Regional planning is the best avenue to achieving balance with population versus resources.
5. The rural area is nonetheless an unused development potential, as long we can do it sustainably, we can insert into development positively.
6. The environmental prospects are directly affected by population distribution, if too much in one centered location the pollution and disproportionate resources are unsustainable.
7. We have historical experience - in both developed and developing countries which have demonstrated that the redistribution of economic activity results in positive impacts on redistributing the population
8. Population-based issues cannot be seen as separate from other issues of development; issues at best are interrelated and interconnected with the economy, society and the environment.
9. Social justice and equal opportunities across regions are a threshold condition for the success of any policy around population or development.
10. The future should be able to utilize technology and innovation as vehicles to attain sustainable spatial population distribution.

### **Recommendations**

1. Mainstream the population dimension in sustainable development programs at national and regional levels.
2. Advance regional planning to provide a more equitable allocation of investment between urban and rural areas.

3. Build infrastructure and essential services in low density areas to attract people and ensure their stability.
4. Support rural development by promoting sustainable agriculture and local industries.
5. Put in place - actionable conscious population policies - addressing growth and available population density and distribution.
6. Deconcentrate urban populations, facilitate the growth of new cities, and new industrial zones in peripheral areas.
7. Learn from enacted - successful, sustainable international examples of population distribution and density appropriate to your context.
8. Activate civil society and media to awaken community population distribution and density importance and urgency.
9. Improve collective international cooperation in sustainable development - and promote the benefits of working together to create partnerships and cooperative technical assistance.
10. Incorporate technology and innovation in all urban planning and rural development efforts to bring about effective actions for an
11. inclusive and sustainable future.

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