

ACADEMIC STUDIES IN ARCHITECTURAL SCIENCES

Editor
MURAT DAL



BİDGE Yayınları

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CHAPTER 1

SEISMIC BEHAVIOR OF ANATOLIAN SELJUK MOSQUES: ERDEMŞAH (KALE-İ CERP) MOSQUE

FATMANUR ATALAY¹

Introduction

Anatolia has hosted many civilizations throughout history, and during this process, it has housed numerous cultural heritage structures built in different periods. Structures such as mosques, minarets, small mosques (mescits), inns, bridges, and palaces are significant examples of this heritage. The preservation of these structures' original characteristics for future generations is only possible by determining how their load-bearing systems behave and, when necessary, applying appropriate repair or strengthening procedures. In this context, the load-bearing systems of many historical structures are analyzed, and interventions are planned, thus ensuring these structures have a long lifespan.

The historical structures that have survived to the present day are mostly religious buildings, palaces, castles, and bridges, which were symbols of prestige during their periods. The load-bearing

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systems of these structures have characteristics different from those of modern engineering structures. Therefore, one of the most suitable methods for engineering analyses of such structures is the finite element analysis (Croci, 1998; Ünay, 2002; Can, Kubin & Ünay, 2012). The most critical stage in this method is the numerical modeling of the structure. Numerical modeling is the expression of load-bearing elements with different material types and variable cross-sections through mathematical models in accordance with the fundamental principles of mechanics (Can, Kubin & Ünay, 2012).

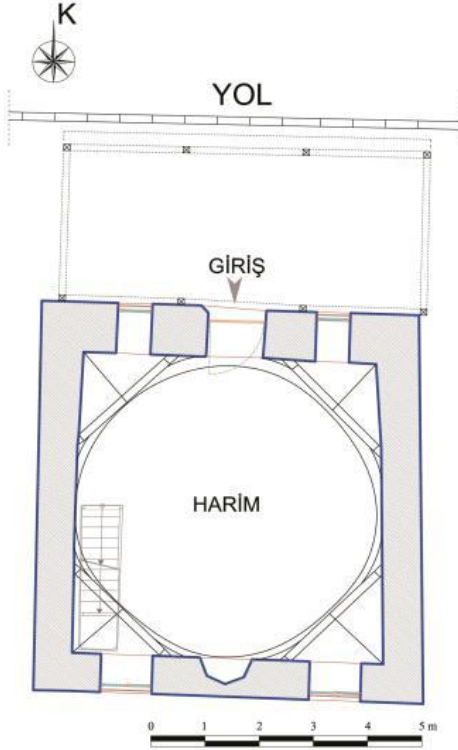
Neighborhood mosques, which are frequently encountered during the Anatolian Seljuk period and are among the prominent examples of Islamic architecture, hold a special place in understanding the architectural style and ornamental approach of that era. Generally built by the local community or notable figures, these mosques have, over time, become integrated with the neighborhood and turned into part of the local identity. These structures, which have been repaired and strengthened, continue to preserve their cultural value today.

In this context, this study on the Erdemşah (Kale-i Cerp) Mosque, located on Sakarya Street in the Meram district of Konya province, aims to evaluate the structural system behavior and earthquake resistance of the building. According to the information on its inscription, the mosque was built in 1220 during the reign of Seljuk Sultan Alaeddin Keykubat by Şemseddin Erdemşah, son of Hacı İsmail (Önder, 1971). The structure, which was built in the 13th century for worship purposes, continues to serve the same function today.

The mosque has a two-space plan consisting of a square-plan prayer hall (harim) and a semi-open entrance section. The general layout of the building is shown in Figure 1. The last congregation area is covered with a sloped roof, while the prayer hall is topped with a dome. However, according to some sources, the last

congregation area previously consisted of small spaces covered with domes or vaults (Konyalı, 1964).

Figure 1 Current plan of Erdemşah Mosque



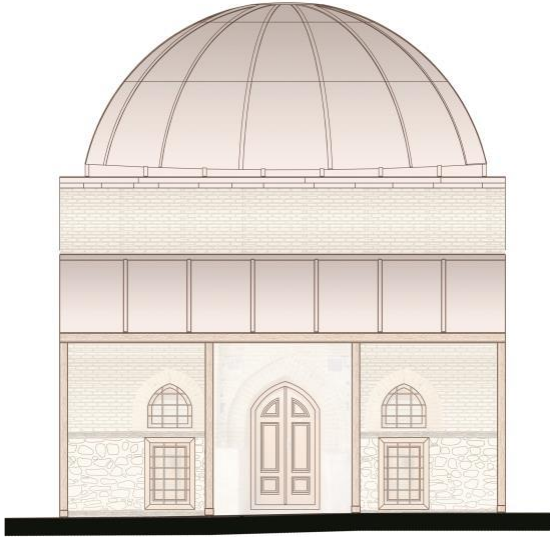
Source: Turan, 2018

On the northern façade of the mosque, there is the last congregation area, which was added to the structure later, and the pointed-arch entrance to the prayer hall (harim) with a wooden door. Just above the entrance door, some remnants of tile decorations draw attention. There is a window on each side of the door. While the lower parts of the exterior façade walls of the structure were built with rubble stone, the upper parts were completed with brick material. The dome is entirely built of brick, and the last congregation area on the north is covered with felt roofing (Turan,

2018). The northern façade view reflecting the current state of the structure is presented in Figure 2, and the sectional view is presented in Figure 3.

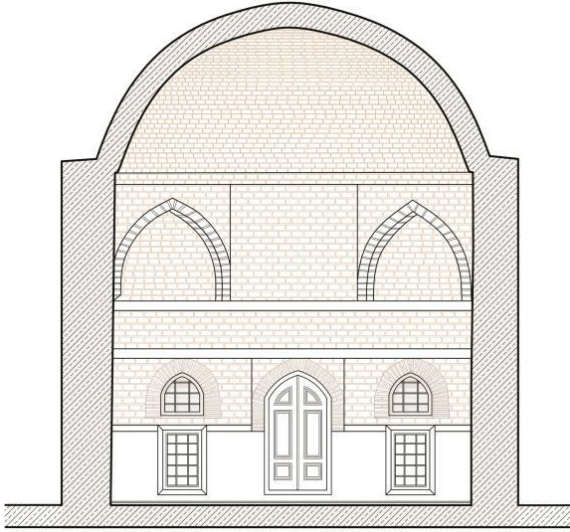
Erdemşah Mosque has a square plan measuring 6.75 meters by 6.75 meters. The dome covering this square area has a diameter of 5.70 meters, and the top of the dome is 6.70 meters above the ground. The load-bearing wall thickness of the structure has been measured as 75 cm; the brick elements used in the transition to the dome are 40 cm thick. The dome itself has a thickness of 35 cm (Turan, 2018).

Figure 2 Current northern façade of Erdemşah Mosque



Source: Turan, 2018

Figure 3 Erdemşah Mosque current sectional view



Source: Turan, 2018

Creation of the Finite Element Model and Outline of the Computational Analysis

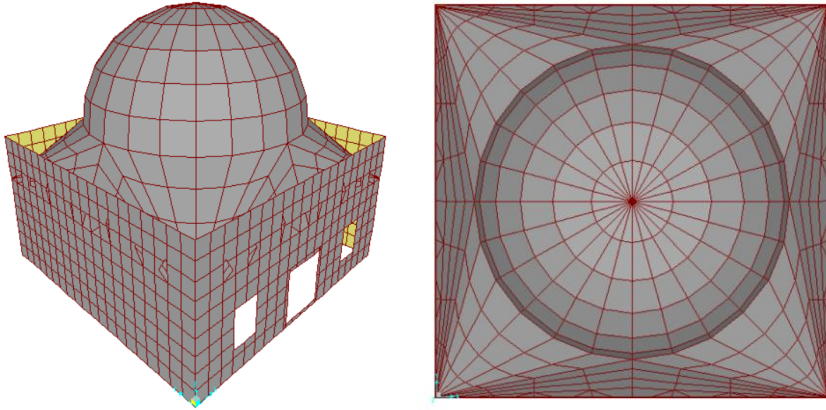
The finite element model of Erdemşah (Kale-i Cerp) Mosque was created in accordance with the modeling rules provided by SAP2000 software (SAP2000, 2020). All geometric dimensions necessary for creating the numerical model of the structure were obtained from previously prepared measured drawing (röleve) projects. The method followed during the modeling process and the determined calculation parameters can be summarized as follows:

- The main dome of the structure, transition elements, and main load-bearing walls were represented using SHELL elements.
- The model was created with a total of 1,128 nodes and 1,104 SHELL elements.

- Material properties were determined using data obtained from the analyses of similar historical structures and recommendations from international literature, and the values recommended for masonry structures in the current Earthquake Code were also considered (Can, Kubin & Ünay, 2012; Regulation, 2007; Giordano, Mele & De Luca, 2001).
- It was assumed that the brick and stone material, together with the mortar, behaved as a single structural element, and the accepted values for the modulus of elasticity and unit weight were determined accordingly
- Two basic loading conditions were considered in the model: dead loads and horizontal ground motions based on the earthquake spectrum. The earthquake effects were applied separately in both the X axis (EQx) and Y axis (EQy) directions.
- For the evaluation of analysis results, two different load combinations were created: G + EQx (dead loads and earthquake effect in the X direction) and G + EQy (dead loads and earthquake effect in the Y direction).
- During the evaluation process, no reduction was applied to the earthquake or dead loads, and the R coefficient was taken as 1. The calculated stress values were compared with limit values obtained by multiplying the allowable stresses by 3.

The perspective and roof views of the model of Erdemşah Mosque created in SAP2000 are presented in Figure 4.

Figure 4 Erdemşah Mosque finite element model perspective and roof view



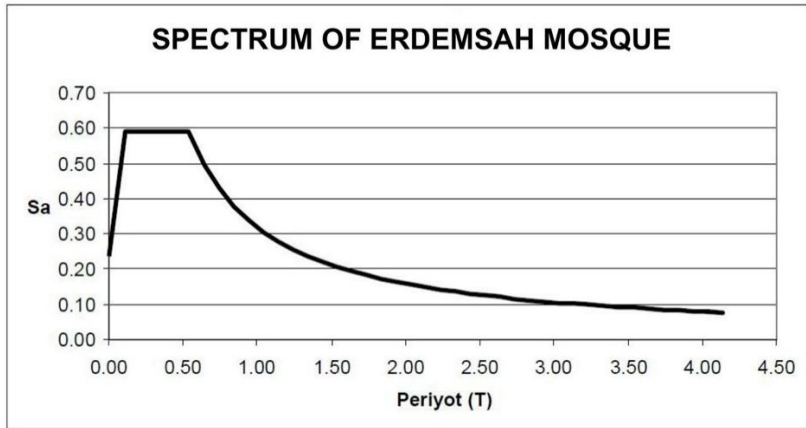
Some material properties assumed in the finite element model of Erdemşah (Kale-i Cerp) Mosque are summarized in Table 1.

Table 1 Material Properties Determined for the Numerical Model of Erdemşah Mosque

Element Type	Modulus of Elasticity E (kN/m ²)	Unit Weight (kN/m ³)	Mass (t/m ³)
Brick Dome and transition element (with mortar)	1200000 (1200 MPa)	24	2,45
Stone Walls (with mortar)	450000 (450 MPa)	24	2,45

The spectrum curve used in the evaluation of the dynamic behavior of the structure is given in Figure 5.

Figure 5 Spectrum curve for the dynamic analysis of Erdemşah Mosque



According to the current Earthquake Code (Yönetmelik, 2007), the maximum allowable compressive stress is specified as $f_{em} = 0.8$ MPa for brick masonry walls and $f_{em} = 0.3$ MPa for stone masonry walls. The earthquake resistance of Erdemşah Mosque is evaluated by comparing the stress values obtained from the analyses with these limit values. No reduction factor was applied during the analysis process, and the R value was assumed to be 1.

The structural analyses of the building were carried out using the SAP2000 finite element software in accordance with the loading combinations shown in Table 2. Since it is quite difficult to examine the displacement, internal force, and stress values generated at all nodes and load-bearing elements of the model in detail one by one, the evaluations were made using the color-scaled distribution maps and stress contour images generated by SAP2000, focusing on the most critical regions (SAP2000, 2020).

Table 2 Safety Stress Limits for Different Material Types

Material Type	Compressive Stress (MPa)	Tensile Safety Stress (MPa)	Shear Safety Stress (MPa)
Brick dome and transition element	2.4	0.36	1.05
Stone walls	0.9	0.135	0.53

Evaluation of the Calculation Results

In this section, the results of the stress calculations based on the finite element analysis, carried out to reveal the structural performance of Erdemşah Mosque under a possible earthquake effect, are evaluated. The findings obtained within the scope of the analysis provide a comprehensive idea about the overall earthquake resistance of the structure.

In the modeling performed using SAP2000 software, the stresses obtained in the SHELL elements were examined. Among these stresses, the vertical (S22) compressive/tensile stresses defined according to the local axis system of each element and the in-plane (S12) shear stresses were considered as the parameters best reflecting the seismic behavior of the structure. S22 represents the normal stresses generated by vertical loads, while S12 represents the shear stresses developed due to horizontal earthquake forces.

As a result of the earthquake loadings applied to the structure, the maximum displacement was calculated as 30 mm in the X direction and 29 mm in the Y direction. Figure 6 shows the displacement distributions occurring on the structure. The main load-bearing elements affecting the structure's response to the earthquake were analyzed through the stress maps given in Figures 7 and 8. These maps were prepared separately for the G + EQx and G + EQy load combinations and reveal the most stressed regions of the structure.

Figure 6 Displacement distributions of the structure in the X and Y directions as a result of earthquake loadings

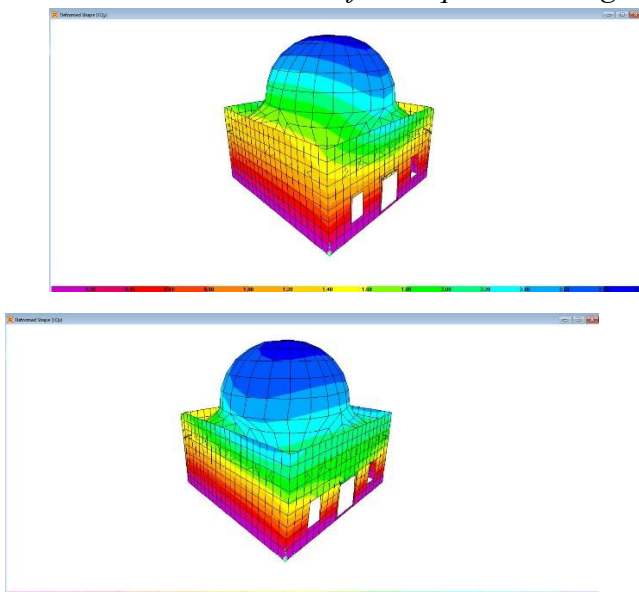


Figure 7 General distribution of S22 tensile stresses under $G+EQ_x$ and $G+EQ_y$ load combinations

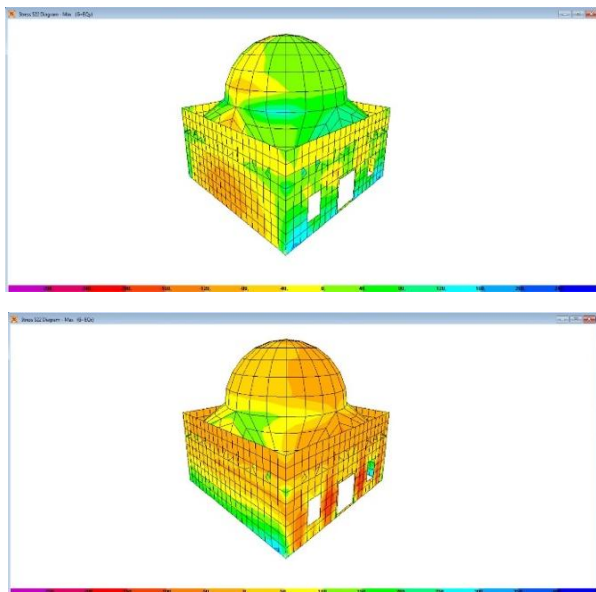


Figure 8 S22 tensile stresses exceeding the limit value as a result of $G+EQ_x$ and $G+EQ_y$ loadings

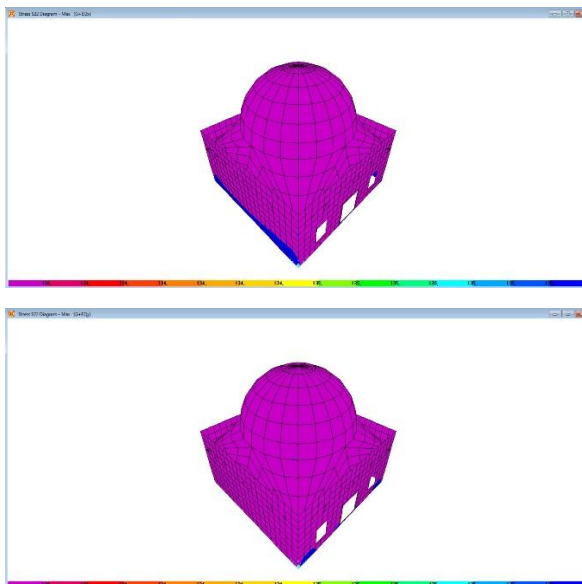


Figure 9 SI2 shear stresses occurring in the dome region due to $G+EQ_x$ and $G+EQ_y$ load combinations

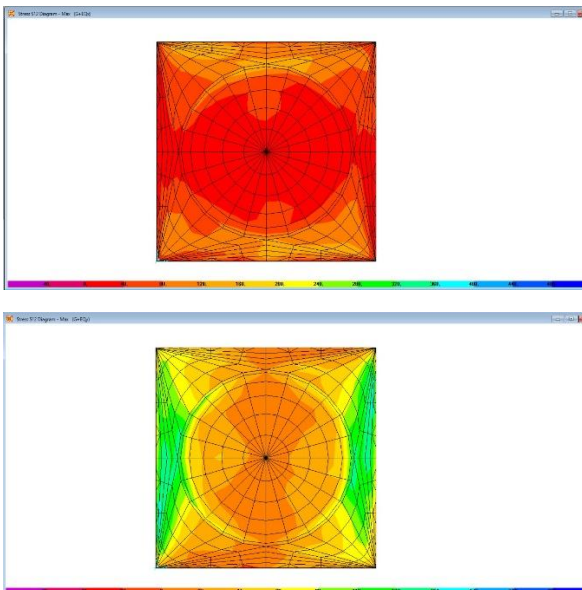


Figure 7 visualizes the S22 tensile stresses occurring under the G + EQx and G + EQy combinations. These stresses, especially those occurring on the walls supporting the dome, are of critical importance in analyzing the behavior of the structure under horizontal forces. In Figure 8, regions on these walls where the tensile stress, considered as a limit value ($f_m(\text{tensile}) = 0.135 \text{ MPa}$), exceeds twice this value (0.27 MPa) are marked in blue, emphasizing that these areas should be carefully evaluated in terms of structural safety. Finally, Figure 9 shows the S12 shear stresses occurring on the main dome. This map provides guidance for evaluating the shear behavior of the dome under earthquake loads.

The characteristic load-bearing elements that affect the overall behavior of the structure are presented in detail in the relevant figures, and both S22 (tensile/compressive) and S12 (shear) stresses have been evaluated based on the G + EQx and G + EQy load combinations. The stress distribution maps created separately for both loading scenarios are important for visualizing the regions where high stress concentrations occur in the structure.

In this context, the load-bearing system was examined under two main headings: the dome and the walls. For each structural element group, the maximum compressive and tensile stresses (S22) occurring on both the upper and lower surfaces are presented in detail in Table 3, while the shear stresses (S12) are detailed in Table 4.

Table 3 Maximum Stresses (S22) Occurring in Different Load-Bearing Element Groups

Element Group			G+EQx Loading MPa	G+EQy Loading MPa
Dome and Transition Elements	Upper Surface	Compressive Stress	-0.12	-0.1
		Tensile Stress	0.1	0.12
	Lower Surface	Compressive Stress	-0.13	-0.15
		Tensile Stress	0	0
Walls	Upper Surface	Compressive Stress	-0.1	-0.11
		Tensile Stress	0.32	0.17
	Lower Surface	Compressive Stress	-0.2	-0.1
		Tensile Stress	0.15	0

Tab e 4 Shear Stresses (S12) Observed on the Upper and Lower Surfaces by Structural Elements

Element Group		G+EQx Loading MPa	G+EQy Loading MPa
Dome and Transition Elements	Upper Surface	0.13	0.15
	Alt Yüzey	0.1	0.1
Walls	Lower Surface	0.18	0.1
	Alt Yüzey	0.17	0.1

Evaluation of the Analysis and Conclusion

The main factor affecting the structural safety and resistance levels of historical buildings is their capacity to withstand various external effects and loads. Therefore, in engineering analyses for historical structures, it is of great importance to accurately estimate load types, transfer these loads to the structural model without error, and carry out the analysis based on a reliable structural representation.

In this context, a finite element model was created for the structural analysis of Erdemşah (Kale-i Cerp) Mosque, based on the assumption of linear elastic material, and the structure was evaluated under a possible earthquake effect. As a result of the comprehensive analyses conducted, the following findings were obtained regarding the seismic behavior of the mosque:

- The structure generally exhibits a rigid character; this indicates that the structure shows controlled displacement behavior as a whole against horizontal loads.
- As a result of the spectral analysis, the maximum displacements occurring at the highest point of the dome were calculated as 30 mm in the X direction and 29 mm in the Y direction. These values are acceptable for small-scale historical structures.
- In the evaluation of the structure, not only the maximum displacement but also the displacement ratios at all node points should be considered. This distribution is important for identifying local stress concentrations and structural weaknesses.
- As a result of the stress analyses, it was observed that the pressure and shear stress limit values specified for masonry structures in the Turkish Earthquake Code were not exceeded in the load-bearing elements.
- The tensile stresses only exceeded the limit value in a limited surface area in the lower corner regions of the walls. However, these types of local tensile stresses were considered acceptable within the scope of the analysis, taking into account the geometry of the structure and the support conditions.

- The material parameters used in the analysis are consistent with the experimental and theoretical data recommended in the literature. However, material deterioration or deficiencies that may be encountered in practice may affect the behavior of the structure. Nevertheless, the displacement and stress levels obtained in the analysis indicate that even such hypothetical weaknesses would not seriously endanger the structural integrity.

As a result; despite the small scale of the structure, thanks to the regularity of its load-bearing system and the proper definition of material properties, the analyses performed using the finite element method have produced highly reliable results. Indeed, many academic studies emphasize that the finite element method is one of the most effective methods for determining the seismic performance of historical structures.

In line with the data obtained within the scope of this study, it can be said that the Erdemşah Mosque has sufficient resistance capacity under a possible earthquake effect, based on its current structural condition and modeling principles. However, it is important that these analysis results are used as a guide during future restoration, strengthening, or repair works.

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CHAPTER 2

ORIGINS OF KINDERGARTEN: A JOURNEY FROM 19TH TO THE 20TH CENTURY

UMAY BEKTAŞ¹
İLKAY ÖZDEMİR²

Introduction

Early childhood is a critical phase in which the foundations of an individual's physical, cognitive, emotional, and social development are established. Educational environments provided during this period play a decisive role not only in knowledge transmission but also in personality development, social interaction, and life skills. In this context, spaces designed for children bear educational, psychological, and social implications. Kindergartens emerge as unique structures that meet these needs and serve as the setting for children's first learning experiences. The first "Kindergarten," founded by Friedrich Fröbel in Germany in 1837, marked the starting point of this approach both architecturally and pedagogically. This model, as adopted and adapted across various cultures, laid the foundation for early childhood education

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worldwide. In the Ottoman Empire, the concept was introduced into the education system at the beginning of the 20th century, and the institutionalization process began with the establishment of the first official kindergartens in 1909.

The aim of this study is to examine the historical development of the kindergarten concept from the 19th century to the mid-20th century, focusing on its architectural and pedagogical dimensions. It reveals how the implementation of kindergartens has been shaped across different cultures. Within this scope, the study adopts a multidimensional perspective to address the influence of pioneering figures such as Fröbel and Montessori, the reflections of socio-political developments—such as industrialization and urbanization—on kindergarten architecture, and the impacts of these structures on child development.

The research was conducted using a qualitative methodology. Through historical document analysis, the architectural planning and pedagogical approaches of the first kindergartens established in various regions of the world were examined. A comparative analysis was also carried out between these international examples and the early kindergarten practices in the Ottoman Empire and the initial years of the Republic of Turkey. The study also examines the global development of the kindergarten concept from the late 19th century until the First World War. It aims to reveal how the kindergarten model initiated by Friedrich Fröbel was adopted in different geographical, social, and political contexts. The historical, pedagogical, and cultural dynamics of early childhood education environments have been analyzed within this framework.

In this context, the study focuses on:

- The expansion of the kindergarten concept from Europe to North America, Asia, and other regions,

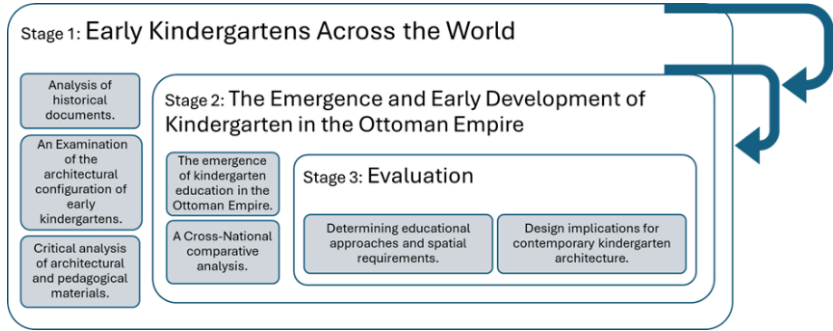
- The influence of key figures and pedagogical approaches, such as Friedrich Fröbel and Maria Montessori,
- The role of societal transformations—such as industrialization, urbanization, and educational reforms—in the development of kindergartens,
- The shaping impact of cultural differences and local needs on kindergarten education.

The literature review enabled a multidimensional exploration of both pedagogical developments and architectural design trends. Consequently, the study has been able to analyze the spatial and educational transformation of the kindergarten concept within a framework of historical continuity. The collected textual and visual data were structured using thematic analysis, thereby contributing to the theoretical foundation of the research.

This study is structured around a three-phase research process within the context of the architectural discipline. In the first phase, a conceptual framework was established based on pedagogical and spatial theories related to children's environments. Within this framework, early childhood education buildings constructed under the title of "kindergarten" since the 19th century in various geographical regions were examined.

The second phase focused on the first kindergartens established in the Ottoman Empire, which were evaluated in comparison with global examples in terms of their planning principles and pedagogical references. In the third and final phase, the interaction between architectural design and pedagogical needs was analyzed based on the data obtained, leading to insights into contemporary kindergarten design. In this way, a theoretical continuity was established between historical context and current design approaches (Figure 1).

Figure 1. Stages of work



Reference: Bektaş, 2025

The kindergartens addressed in this study were identified through the analysis of documents obtained from the literature, covering the period from the establishment of the first kindergarten in the world up to the First World War. During World War I (1914–1918), educational activities were interrupted in many countries due to the challenges posed by the war. One of the main reasons for this disruption was the conscription of many teachers and students. The mobilization of the young population particularly had a negative impact on the functioning of educational institutions.

The economic burden brought by the war led governments to redirect their budgets toward military expenditures, resulting in a decrease in the resources allocated to civilian sectors such as education. For example, although the decline in educational spending in the Ottoman Empire during the war years was relatively limited compared to other areas, investments in education were still affected due to the allocation of the majority of the budget to military expenses. In regions where the war was most intense, school buildings were damaged or completely destroyed due to bombings and armed conflicts. This situation led to the cessation or disruption of educational activities (Günergün, 2018). Families living in war zones were hesitant to send their children to school for safety reasons

or were forced to migrate, which negatively affected student attendance and continuity.

In this context, the global review and the analysis of the Ottoman Empire and the Republic of Turkey—outlined in the first and second stages of the study—are discussed in the findings section. The third stage, which involves the evaluation of the results, is addressed in the conclusion and recommendations section.

Children's Spatial Environments

The design of children's environments should be approached in accordance with both theoretical and functional principles that holistically support their physical, cognitive, and social development. In this context, several fundamental principles—such as safety, accessibility, flexibility, aesthetics, natural elements, social interaction, educational opportunities, cultural sensitivity, and sustainability—must be carefully considered.

The requirement for safety in children's spaces is particularly significant in preventing accidents, especially in play areas. Accordingly, surfaces should be covered with soft materials, and accessibility for children with disabilities must be considered (Gür & Zorlu, 2002; Barbour, 1999; Wells et al., 2015). The flexibility and multifunctionality of spaces support the play and learning processes of children across different age groups. In addition, the use of modular equipment fosters creativity (Czalczyńska-Podolska, 2014).

In addition, the use of aesthetic and natural elements within spaces fosters children's connection with their environment and promotes environmental awareness (Dudek, 2005; Mårtensson et al., 2009). Furthermore, spaces that encourage social interaction contribute to the development of children's social skills (Frost et al., 2012). As cultural sensitivity and sustainability are integrated into spatial design, environments created with eco-friendly materials that

reflect local values come to the forefront (Şahin, 2018; Kyttä et al., 2013).

Ultimately, space acquires meaning through its users; the user is a whole entity, and to serve them effectively, the space must be carefully and functionally organized. Spatial design must respond to all needs and expectations of its users by ensuring safety, openness, flexibility, appropriate dimensions, comfort, and high aesthetic value (Özdemir, 1994). When the primary user is a child, this responsibility becomes even more critical. The design must be approached with greater sensitivity to provide environments that holistically support children's physical, cognitive, and social growth.

Historical and Pedagogical Concept of “Kindergarten”

The concept of kindergarten emerged as an educational model emphasizing the importance of early childhood education and aiming to support children’s cognitive, emotional, and social development. The foundations of this concept were laid in the early 19th century, and over time, it has been adapted and implemented in various ways across different countries.

German educator Friedrich Fröbel, widely recognized as the pioneer of kindergarten, established the first Kindergarten (“children’s garden”) in Germany in 1837. He advocated for learning through play, a pedagogical approach that laid the groundwork for modern early childhood education. His methods aimed to align with children’s natural developmental processes and to foster creativity through guided exploration.

Building upon Fröbel’s ideas, Italian educator Maria Montessori opened her first school, Casa dei Bambini (“Children’s House”), in Rome in 1907 (Montessori, 1912). Montessori developed an educational model that emphasized children's capacity for self-directed learning. Her method introduced a carefully prepared environment and specially designed learning materials that

enabled children to explore independently. The Montessori approach gained global recognition and continues to be widely practiced today.

The concept of kindergarten is approached in many different ways across countries. For instance, the work of Swiss educator Johann Heinrich Pestalozzi (1746–1827) advocated for a holistic approach to children's emotional and intellectual development (Pestalozzi, 1827). Pestalozzi's ideas significantly influenced later educational theorists such as Fröbel and Montessori, and contributed to the evolution of early childhood education models.

In the Ottoman Empire, the notion of kindergarten began to gain prominence in the early 20th century. While private kindergartens were established in several provinces as early as 1908, the foundation of official state kindergartens took place in 1913 (Akyüz, 2023). These institutions initially functioned as preparatory stages for primary education. After the proclamation of the Republic in 1923, early childhood education institutions continued to operate, and their number gradually increased over time.

Findings emphasizing the importance of early childhood education have played a significant role in shaping the concept of kindergarten. Especially from the mid-20th century onward, scientific research has demonstrated that preschool education positively influences children's cognitive achievements as well as their social development (Piaget, 1952; Vygotsky, 1978). Such empirical evidence has increased interest in early childhood education in many countries and has been instrumental in the widespread adoption of this educational model.

Today, kindergartens not only serve to prepare children for academic learning but also aim to support their social and emotional development. The education provided in these institutions helps children enhance their language, numeracy, and motor skills, while

also enabling them to acquire social competencies such as peer interaction, sharing, and empathy. Furthermore, play-based learning models foster children's imagination and support their abilities in creative thinking and problem-solving (Singer, Golinkoff & Hirsh-Pasek, 2006).

In light of all these developments, kindergarten is now considered not only an educational institution but also a comprehensive developmental space that contributes to the formation of children's personalities. Friedrich Froebel, one of the pioneers of this understanding, emphasized the child's relationship with nature and learning through play, while Maria Montessori advocated for a learning environment tailored to the child's individual development. These pioneering approaches have gradually been adopted in various cultures and, through localized adaptations, have gained universal significance.

In conclusion, the kindergarten concept reflects pedagogical approaches that emphasize the need to support children from an early age. Considering that high-quality education in early childhood directly influences a person's lifelong learning capacity, the importance of kindergartens within educational systems is increasingly being recognized.

Early Kindergartens Across the World

This section first examines 20 kindergartens included in the study, focusing on their founding purposes, pedagogical philosophies, and architectural design principles. Following this, the first kindergartens established in Ottoman Empire are analyzed in terms of their architectural characteristics and educational approaches (Table 1).

Table 1. Overview of Early Kindergartens Examined in the Study

<i>Year</i>	<i>Name</i>	<i>Location</i>	<i>Founder</i>
1816	Robert Owen's Infant School	New Lanark, Scotland	Robert Owen
1820	Samuel Wilderspin's Infant School	London, England	Samuel Wilderspin
1837	Froebel's Kindergarten	Bad Blankenburg, Germany	Friedrich Froebel
1856	Margarethe Schurz's Kindergarten	Watertown, Wisconsin, ABD	Margarethe Schurz
1859	Bertha von Marenholtz-Bülow's Kindergarten	Dresden, Germany	Bertha von Marenholtz-Bülow
1860	Elizabeth Peabody's Kindergarten	Boston, Massachusetts, USA	Elizabeth Peabody
1863	First Russian Kindergarten	St. Petersburg, Russia	Adelaida Simonovich
1872	Kindergarten der Stadt Wien	Vienna, Austria	Vienna City Administration
1875	First Brazilian Kindergarten	São Paulo, Brazil	Maria Antonieta de Castro
1876	Kindergarten of Tokyo Women's Normal School	Tokyo, Japan	Japan Government
1881	First Mexican Kindergarten	Mexico City, Mexico	Rosaura Zapata
1883	First Canadian Kindergarten	Toronto, Canada	James Hughes

884	First Argentine Kindergarten	Buenos Aires, Argentina	Juana Manso
889	First New Zealand Kindergarten	Dunedin, New Zealand	Rachel Reynolds
895	First Australian Kindergarten	Sydney, Australia	Maybank Anderson
903	First Chinese Kindergarten	Shanghai, China	Cai Yuanpei
906	First Chilean Kindergarten	Santiago, Chile	Amanda Labarca
907	Maria Montessori's Casa dei Bambini	Roma, Italy	Maria Montessori
909	First Turkish Kindergarten	İstanbul, Türkiye	Müzeyyen Cemal Hanım
910	First Indian Kindergarten	Mumbai, India	Sophia Pollock

Reference: Bektaş, 2025

The concept of kindergarten, developed by Friedrich Fröbel in the early 19th century, initiated a global transformation in early childhood education (Pestalozzi, 1827). Fröbel's model rapidly spread across Europe and beyond, influencing educational philosophies and practices within diverse cultural contexts.

By the late 19th century and the early 20th century, the concept of kindergarten had entered a significant phase of development in both Europe and North America. During this period, the work of Elizabeth Peabody in the United States was particularly noteworthy. In the 1850s, Peabody introduced Froebel's educational model and played a key role in rooting this philosophy in American soil. Emphasizing hands-on learning and moral development, the model gained widespread acceptance through the establishment of numerous kindergartens under her leadership (Woodil, 1986).

In the late 19th and early 20th centuries, kindergartens developed geographically in Europe and North America. In America,

Elizabeth Peabody pioneered this process by introducing Fröbel's educational model in the 1850s. Thanks to Peabody's efforts, many kindergartens were established to support children's moral development and hands-on learning (Woodil, 1986). By the 20th century, kindergartens had become an indispensable part of public schools, especially in highly urbanized areas (Tobin, 2016).

In Italy, Maria Montessori adopted a different approach in 1907. The educational model she developed encouraged children to learn on their own, taking into account their individual needs. The environment she created in her school, Casa dei Bambini, was designed to support both the independence and cognitive development of children. Over time, Montessori's approach became internationally recognized and left a lasting impact on early childhood education (Montessori, 1912). In Japan, kindergarten was introduced as part of efforts to modernize the education system during the Meiji period. In 1876, Tokyo Women's Normal School established the country's first kindergarten by blending Fröbel's methods with Japanese culture (Hayashi & Tobin, 2014).

This initiative laid the groundwork for the expansion of kindergartens across East Asia, particularly in China and Korea, during the early 20th century. In China, kindergartens were introduced alongside the Republican-era educational reforms (1911–1949). These institutions, shaped by a combination of Western pedagogical theories and local traditions, aimed to support the moral and intellectual development of children (Qi & Melhuish, 2017). These early implementations collectively formed the foundation of modern early childhood education across different regions of the world.

Robert Owen's Infant School (1816)

The Infant School, established in 1816 in the town of New Lanark, Scotland, was founded by the prominent social reformer

Robert Owen (Vergnon, 2013a). Recognized in educational history as the world's first kindergarten-like institution, this initiative marked a groundbreaking advancement in the field of early childhood education.

Located in New Lanark, the school admitted children as young as 18 months and served approximately 80 children. Owen firmly believed that children in this age group should not be subjected to formal instruction; instead, the curriculum emphasized dance, play, and outdoor activities (Vergnon, 2013a). The physical layout of the school was also carefully designed to allow children to move freely and engage with nature, supporting a child-centered and experiential approach to early learning.

Owen's educational approach was grounded in the belief that education is one of the most effective instruments of social reform. In line with this view, he developed a comprehensive educational system for children, placing particular emphasis on the concept of character formation. Owen advocated for a joyful and interest-based learning process that supported children's natural curiosity. He proposed a play-based curriculum shaped around the interests of the child (Vergnon, 2013a; Vergnon, 2013b).

The Infant School was not built in accordance with a distinct architectural style but rather prioritized functionality in its design. The building featured simple yet effective spaces tailored to meet the physical and emotional needs of children. The extensive use of open areas reflected Owen's emphasis on natural learning environments (Figure 2).

Figure 2. Visual representations of Robert Owen's Infant School



Reference: Donnachie, 2000; Chitwood, 2019

This school served not only as a pioneer in early childhood education but also as a forerunner of community-based education. Owen's educational model is regarded as part of a broader social reform movement aimed at addressing the societal issues of his time (Vergnon, 2013b).

This approach—still relevant today—laid the foundations for child-centered and play-based education. Robert Owen's pioneering initiative in New Lanark marked a significant turning point in the evolution of preschool education and continues to inspire future generations.

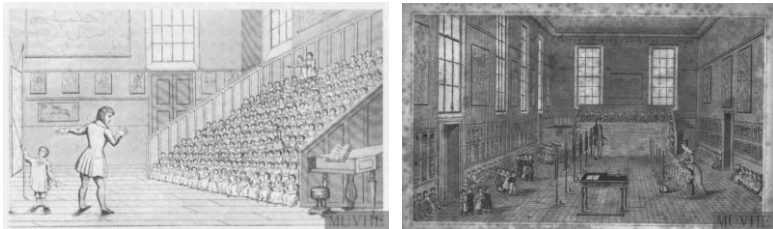
Samuel Wilderspin's Infant School (1820)

The kindergarten established by Samuel Wilderspin was opened in 1820 in the Spitalfields district of London, England. Wilderspin, recognized as one of the pioneers of early childhood education, based this institution on his practical educational experiences (McCann, 1966). In 1823, he published his influential work, *On the Importance of Educating the Infant Poor*, in which he articulated his educational philosophy and methods.

The school adopted play-based learning methods developed by Wilderspin. He placed particular emphasis on the educational function of schoolyards, designing outdoor play areas and gardens to support both the physical and cognitive development of young children (WNS, 2020). These outdoor environments were structured not only for play but also to promote experiential learning through direct interaction with nature. The architectural layout of the school

was aligned with Wilderspin's pedagogical principles. Classroom arrangements and instructional materials were designed to stimulate children's natural curiosity (Figure 3).

Figure 3. Interior views of Samuel Wilderspin's Infant School, illustrating the spatial layout and educational materials



Reference: Virtual, 2005a; Virtual, 2005b

These spatial configurations allowed children to learn according to their interests and supported their individual development (McCann & Young, 1982).

Froebel's Kindergarten (1837)

The Froebel Kindergarten was established in 1837 in the town of Bad Blankenburg, Germany, by Friedrich Fröbel, who is widely regarded as the founder of modern early childhood education (Prochner, 2009). Fröbel developed an innovative educational model that encouraged children to learn through play and structured activities.

Fröbel's philosophy of education was grounded in the belief that children's natural developmental processes should be respected. He likened education to gardening—where growth requires care and patience—and thus named his institution Kindergarten, meaning "children's garden." The curriculum included a wide range of activities such as games, singing, dancing, and gardening, all designed to support children's intellectual, emotional, and social development (Bruce, 2012).

The physical design of the school and its learning environment were carefully aligned with Fröbel's play-based approach. Emphasis was placed on creating a space where children could learn through hands-on experiences and enjoyment. Within this context, Fröbel also developed specialized educational tools for children (Figure 4). Known as Fröbel's Gifts, these materials consisted of toys and learning activities intended to foster conceptual thinking skills (Smith, 2014).

Figure 4. Visual representations of the Froebel Kindergarten



Reference: Chitwood, 2019; Tanajah, 2017

Fröbel's pioneering initiative has been recognized as one of the cornerstones of modern early childhood education. The kindergarten he founded in Bad Blankenburg inspired educators around the world and played a leading role in the development of child-centered and play-based instructional approaches. Friedrich Fröbel's philosophy continues to serve as a foundational element in pedagogical models that remain relevant in contemporary educational practice.

Margarethe Schurz's Kindergarten (1856)

The first kindergarten in the United States was established in 1856 in the city of Watertown, located in the state of Wisconsin. The school was founded by Margarethe Meyer Schurz, who was born in Hamburg, Germany, and deeply influenced by Friedrich Fröbel's educational philosophy (Petig, 2017).

The historical significance of the kindergarten founded in Watertown has evolved into a symbol within the history of education. In 1956, the original structure was restored and relocated next to the Octagon House Museum, where it now operates as a museum. Visitors can explore the historical development of the first kindergarten in America and witness how the Froebelian approach was implemented in practice.

Bertha von Marenholtz-Bülow's Kindergarten (1859)

The kindergarten established in the city of Dresden, Germany, stands out as one of the earliest institutional examples in the field of early childhood education based on the ideas of Friedrich Fröbel. The friendship between the Baroness and Fröbel dates back to 1850. In this way, the Baroness carried Fröbel's educational philosophy based on play and activity not only in Germany but also in various parts of Europe. Kindertagens established in countries such as France, Belgium and Italy were shaped by Fröbelian principles thanks to her initiatives and guidance (Web, 2008). In order to bring his understanding of education to a wider audience, he collected his experiences of Fröbel in the book “Erinnerungen an Fröbel” (Memories from Fröbel). This work documents not only Fröbel's philosophy of education, but also her contribution to the introduction of his pedagogical methods in Europe (Bülow-Wendhausen, 1901).

The charitable kindertagens and a training school founded by the Baroness were later moved to Dresden. The charitable kindertagens and an educational school she founded in Berlin were later moved to Dresden, where they became a center for the systematic application of Fröbel's educational methods (Web, 2008). This institution offered a play-based learning environment that supported children's natural development. Through her work, the Baroness not only spread the concept of kindergarten to different

parts of Europe, but also raised awareness about the participation of women and charitable organizations in education (Kindergarten, 2015).

The kindergarten in Dresden was architecturally designed with functional educational spaces that allowed children to engage comfortably in a variety of activities. In accordance with Baroness Marenholtz-Bülow's pedagogical principles, the institution served not only as a center for hands-on early childhood education but also as a teacher training facility.

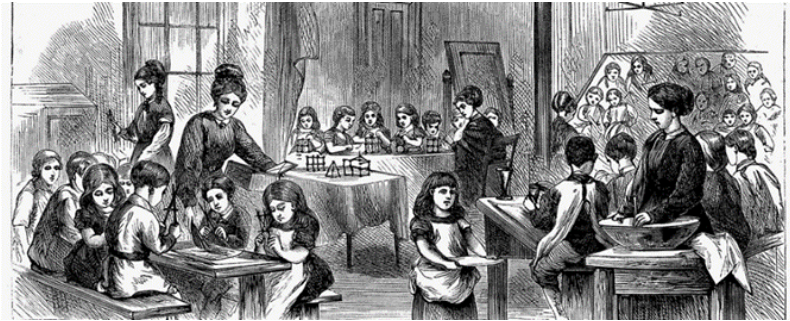
Elizabeth Peabody's Kindergarten (1860)

The first kindergarten was established in 1860 in Boston, Massachusetts, United States of America by Elizabeth Palmer Peabody, an American educator and one of the educators who adopted the Transcendentalist philosophy (Britannica, 2025). With this initiative, Peabody became the founder of the first English-speaking kindergarten in America.

Peabody was influenced by Friedrich Fröbel's educational philosophy and became interested in the kindergarten movement after meeting Margarethe Meyer Schurz, who founded a German-speaking kindergarten in Wisconsin in 1856. She made an educational visit to Germany in 1867 to learn more about Fröbel's methods (Lazerson, 1971).

The Boston kindergarten provided a play-based educational environment that promoted children's learning through activities such as singing, playing, music, and movement (Figure 6). The classroom was designed to meet the developmental needs and ages of young children, with furniture arranged in a flexible and movable manner to accommodate various learning scenarios (Peabody & Mann, 1863).

Figure 6. Historical illustration of Elizabeth Peabody's kindergarten



Reference: Richardson, 2018

Peabody was not only an educator but also a publisher and teacher trainer who played a pivotal role in promoting the kindergarten movement. In 1863, she co-authored *Guide to the Kindergarten and Moral Culture of Infancy* with her sister Mary Tyler Peabody Mann, a work widely regarded as one of the most authoritative sources on the theory and practice of kindergarten during that period (Ronda, 1999).

In addition, between 1873 and 1877, Peabody published the periodical *Kindergarten Messenger* and, in 1877, founded the American Froebel Union. These efforts significantly contributed to the institutionalization of Froebelian education and the broader dissemination of the kindergarten model throughout the United States.

First Russian Kindergarten (1863)

The first kindergarten in St. Petersburg was established in 1863, in the capital of the Russian Empire, by Adelaida Semyonovna Simonovich, a Russian educator and publisher (Pomelov, 2024). Through this initiative, Simonovich became one of the pioneering figures in laying the foundations of early childhood education in Russia.

Having studied kindergarten practices in Switzerland, Simonovich was particularly influenced by the pedagogy of Friedrich Fröbel. However, rather than applying Fröbel's methods directly, she chose to adapt them to fit Russian cultural and national values. Her approach was shaped through the integration of ideas from leading Russian educational thinkers of the time, such as K.D. Ushinsky, E.N. Vodovosova, L.N. Tolstoy, and A.S. Simonovich (Valkanova & Brehony, 2006).

The kindergarten Simonovich founded in St. Petersburg was one of the first initiatives he and his wife realized. This kindergarten, which was opened for the children of Russia's urban populace and emerging middle class families, adopted Fröbel's concept of play-based learning, but adapted this model according to Russian nationalism and social needs.

The school's structure and educational arrangements were designed both to support the individual development of children and to raise them in accordance with social values. Play, activity and moral development played an important role in education; in addition, the school program was enriched with elements reflecting local culture.

Simonovich is recognized not only as a practitioner but also as one of the first Russian theorists of early childhood education. As both an educator and publisher, she produced numerous written works on the subject and made significant contributions to the institutionalization of preschool education in Russia (Pomelov, 2024). Under her leadership, the kindergarten concept gained traction across the country and gradually became part of national educational policy. Her pedagogical contributions not only reflected an adaptation of Fröbel's legacy but also marked a profound transformation in the trajectory of Russian educational history.

Kindergarten der Stadt Wien (1872)

The Kindergarten der Stadt Wien (Kindergarten of the City of Vienna) was established in 1872 in Vienna, the capital of Austria. Inspired by the educational methods of Friedrich Fröbel, the institution was founded by the Vienna City Administration to promote preschool education (Frankowski & Liederer, 1926).

During its early years, kindergartens were typically operated by private philanthropic organizations and were open only for a few hours a day. The primary aim of these institutions was to supplement the education children received at home and to facilitate their transition into primary school (Figure 7).

Figure 7. Exterior view of the Kindergarten der Stadt Wien



Reference: Gattringer, 2025

The first publicly funded kindergartens in Vienna were established between 1889 and 1893. A significant milestone in the development of early childhood education in Austria was the First Austrian Kindergarten Teachers' Day, held in 1912, which highlighted the dual educational and social functions of kindergartens. This event helped raise public awareness about the importance of these institutions, contributing directly to the increase in the number of kindergartens and the improvement of educational quality in Vienna.

The kindergartens in Vienna saw significant reorganization in the 1920s. In order to encourage children's psychological development, a new style of learning that was based on play and free activities was established. Accordingly, in 1925, Waldmüllerpark, in

the 10th district of Vienna, became the site of a model kindergarten founded on Fröbelian principles (Gattringer, 2025).

New kindergartens were also built at this time in working-class communities, developing along with the city's housing projects. In addition to improving the wellbeing of children from lower-income families, these institutions were essential in increasing access to early childhood education.

First Brazilian Kindergarten (1875)

In 1875, the first kindergarten was established in Rio de Janeiro under the supervision of Colégio Menezes Vieira, laying the institutional groundwork for early childhood education in Brazil. Teacher Joaquim José de Menezes Vieira spearheaded this innovative project, which is recognized as both a Brazilian first and the beginning of a larger movement that influenced the development of preschool education across Latin America.

European modern pedagogical techniques had a significant effect on Vieira's kindergarten program. The theoretical foundation of this methodology was specifically supplied by Friedrich Fröbel and Marie Pape-Carpantier's educational resources and Johann Heinrich Pestalozzi's intuitive teaching style.

Vieira's educational travels to Belgium, France, and Italy significantly informed the development of the school, both in terms of its pedagogical content and the physical organization of its spaces (Hai et al., 2020). Both the teaching content and the physical layout of the school's facilities were greatly influenced by Vieira's educational trips to Belgium, France, and Italy (Hai et al., 2020).

Although the furniture and equipment in the kindergarten were made locally, the layout was inspired by preschool institutions in France. Classrooms were designed according to the children's ages and development stages. This created spaces that were

accessible, engaging, and supportive of interaction. This approach directly influenced both the physical setting and the teaching process.

The educational program mostly followed Pestalozzi's idea of the "intuitive method." This method focuses on direct engagement with objects through observation and hands-on experience. It encourages children to take part in the learning process by interacting with their surroundings. In Brazil, this approach was accepted not just as a teaching technique but also as a guiding philosophy. It was later included in the primary school curriculum through the Leôncio Carvalho Educational Reform of 1879.

At the kindergarten in Colégio Menezes Vieira, structured games, lessons using objects, and various learning activities were used to support the cognitive, emotional, and social development of children in a well-rounded way. The model developed under Vieira's leadership prioritized individual growth while marking an important move toward modernizing Brazil's education system. This institution acted as a school and as a symbol of educational change, showing how reforms from Europe could fit into the South American context (Hai et al., 2020).

Kindergarten of Tokyo Women's Normal School (1876)

The first kindergarten in Japan was established in 1876 in Tokyo, affiliated with the Tokyo Women's Normal School (present-day Ochanomizu University). This institution emerged as part of the broader modernization and educational reform efforts initiated in Japan following the Meiji Restoration of 1868. The Meiji era marked a profound transformation in Japanese society, particularly in terms of intellectual and educational development (Figure 8). Within this context, the Gakusei (Education System Order) issued in 1872 laid

the foundation for the modern Japanese educational system (Başara Baydilek, 2015).

Figure 8. Illustrative depiction of the play-based learning environment at Japan's first kindergarten



Reference: Kawano, 2016

The kindergarten established in 1876 in Japan adopted Western educational approaches, particularly the play-based and material-centered pedagogy of Friedrich Fröbel (Abumiya, 2011; Liu & Lin, 2018). Fröbel's philosophy encouraged children to learn through interaction with nature and educational materials, and this principle served as the foundation of Japan's first kindergarten.

A key figure in this development was Fujimaro Tanaka, who participated in the Iwakura Mission and studied educational systems in the United States and Europe between 1871 and 1873. Tanaka is recognized as one of the founding figures of early childhood education in Japan. The first director of the kindergarten, Shinzo Seki, played a major role in adapting Fröbelian methods to the Japanese context, publishing various works and contributing to teacher training in the field (Matsukawa, 1990).

Another significant contributor was Clara Matsuno, a German educator trained in Fröbel's pedagogy, who took on the role

of pedagogical leader at the institution. Under her guidance, Fröbel's instructional tools—known as “Gifts”—were introduced to support children's natural learning processes. The kindergarten's curriculum included songs, outdoor activities, puzzles, and free play, all reflecting a child-centered educational model (Contributors, 2025).

This kindergarten is considered one of the first modern early childhood education initiatives not only in Japan but also across Asia. The model, which adapted Fröbel's pedagogical principles to the Japanese cultural context, played a defining role in shaping the trajectory of preschool education in Japan in the decades that followed.

First Mexican Kindergarten (1881)

The first kindergarten in Mexico was established in 1881. Its initial purpose was for the working class children of the rapidly developing and urbanizing Mexican population at the end of the 19th century. In addition to providing a safe and educational education, the kindergarten was influenced by the educational philosophies of Friedrich Fröbel and Johann Heinrich Pestalozzi. The kindergarten first served in rented buildings and later moved to different buildings in order to better reflect the basic elements such as lighting, hygiene and playgrounds in the space (Serrano, 2020).

Although the kindergarten was influenced by the philosophies of different educators when it was first established, over time these philosophies were adapted to the Mexican social and cultural context. Over time, a new model called the “home-school” model emerged. According to this model, children had a learning experience in kindergarten in an educational atmosphere similar to that at home, intertwined with music, play and nature. One of the prominent figures in this process was Laura Méndez de Cuenca. Cuenca studied kindergarten experiences in Saint Louis, Missouri and contributed to the shaping of the first models by bringing these

observations to Mexico (Espinosa, 2013). Rosaura Zapata Cano, who was born in Baja California Sur in 1881, was another important figure in the popularization of kindergarten education in Mexico. Zapata, with the developments and changes he brought about, ensured that new kindergartens were opened in Mexico, especially in the 1920s, and new curricula were developed in line with the educational philosophy he advocated. With Zapata's guidance, kindergartens were institutionalized and significant developments were made in terms of both pedagogical content and physical spaces (Alba, 2013).

These early kindergartens were equipped with both imported and locally produced educational materials. Over time, these materials and practices were adapted to meet local needs, serving as tangible examples of how international models were transformed within the Mexican context.

As Serrano (2020) notes, the development of kindergartens in Mexico represents not only a pedagogical evolution but also a transformation of physical and cultural spaces. These institutions opened new spatial and conceptual domains for children within Mexican society and played a historical role in the institutionalization of early childhood education.

First Canadian Kindergarten (1883)

The first publicly funded kindergarten in Canada was established in 1883 in the city of Toronto. This educational milestone was achieved through the persistent efforts and advocacy of James Hughes, Chief Inspector of the Toronto Public Schools (Wloka, 2020a). Deeply influenced by Friedrich Fröbel's play-based educational model, which originated in Germany, Hughes aimed to incorporate this pedagogical approach into the Canadian public school system (Figure 9). Toronto's initiative positioned it as the second city in North America, after St. Louis, Missouri, to introduce

a state-supported kindergarten within its public education framework (Wloka, 2020b).

Figure 9. Toronto Normal School, 1898



Reference: Images, 2019

The first public kindergarten in Toronto was led by Ada Marean, who played a pivotal role in realizing the educational vision of James Hughes, the Chief Inspector of Public Schools in Toronto. Marean later married Hughes in 1885, and together they became key figures in the development of early childhood education in the region. James Hughes was not only a practitioner but also one of the most vocal advocates of Friedrich Froebel's pedagogical philosophy. By the 1890s, he had gained international recognition as a leading authority on Froebelian education (Ellis, 2003).

This pioneering kindergarten was grounded in a child-centered pedagogical model that emphasized learning through play, activities, and discovery. The physical environment was carefully designed in line with Froebel's educational principles, offering children opportunities for free movement, participation in group activities, and interaction with educational materials specifically suited to their developmental needs.

Ontario became the first—and for a long time, the only—province in Canada to adopt a publicly funded kindergarten system. Under Hughes’s influence, kindergarten education became an integral and enduring part of Ontario’s public education framework. However, interest in publicly supported kindergartens did not gain comparable momentum in other parts of Canada until the mid-20th century (Wloka, 2020b). This divergence underscores the critical role played by Hughes and the early Toronto initiative in shaping the trajectory of early childhood education across the country.

First Argentine Kindergarten (1884)

The first kindergarten in Argentina was established in 1884 in the city of Buenos Aires. This development came after the Lainez Law, which came into force in the same year, officially integrated preschool education into the Argentine education system. With this law, kindergartens were systematized as a service for the children of middle-class families and a pedagogical approach based on educational games was adopted (Rodriguez, 2020).

Kindergartens established with this approach were usually integrated into regular school buildings. It was only in the following years that the concept of kindergarten transitioned to independent structures. As in other kindergartens, Fröbel's “Kindergarten” philosophy was influential in Argentine kindergartens. However, since this philosophy cannot be considered independent from Argentine culture and social characteristics, it has progressed in an integrated manner. Kindergartens functioned not only as places to impart knowledge but also as educational institutions that provided social support to children.

Although the first kindergartens established in Argentina were intended for children from upper and middle class families, children from low-income families were also accepted. However, economic constraints, budgetary problems and uncertainties in

educational policies have limited the expansion of this service (Rodriguez, 2020).

Juana Manso (1819-1875) laid the foundations of preschool education in Argentina in the second half of the 19th century. Not only as an educator but also as a writer, Manso introduced new curricula into the education system. She pioneered important reforms, especially in the fields of women's education and early childhood education, and was known for her advocacy on these issues. Manso was also interested in gender equality. She is also known for her work on the inclusion of girls in the education system (Ponce, 2018).

First New Zealand Kindergarten (1889)

The first kindergarten in New Zealand was established in Dunedin in 1889 under the leadership of social reformer and women's rights activist Rachel Reynolds. This kindergarten was established as part of the Dunedin Kindergarten Movement and its core educational philosophy was Friedrich Fröbel's principles of learning through play. The main aim of this educational movement was to improve children's cognitive development through play, but it also aimed to prevent the social inequalities that were experienced in New Zealand at the time.

Rachel Reynolds, Mark Cohen and Lavinia Kelsey were the most prominent figures in this education movement. Among them, Rachel Reynolds stood out for her advocacy of women's education and for giving education opportunities to children from poor families. Mark Cohen, on the other hand, used his profession as a writer to make Fröbel pedagogy known to the public. Lavinia Kelsey was active in the practical side of education and contributed to the pedagogical development of classroom spaces. Thanks to the efforts of the educators and writers mentioned above, an association called “Dunedin Free Kindergarten Association (DFKA)” was established.

This association, which continues its activities with various donations, aims to provide pre-school education especially to the children of families with economic weakness. Figure 10 shows Rachel Reynolds' kindergarten, which continues its educational activities with the support of both philosophers of education and the association.

Figure 10. Rachel Reynolds Kindergarten Records, 1889



Reference: Collections, 2023

The learning environment was intentionally arranged to allow children to move freely, explore independently, and engage in experiential learning in a stimulating and nurturing atmosphere.

First Australian Kindergarten (1895)

The first kindergarten in Australia was established in 1895 in the Woolloomooloo district of Sydney. This pioneering initiative was led by Maybanke Anderson, a notable social reformer and educator. As Brennan (1998) points out, this effort marked one of the earliest examples of shifting child care in Australia from a charitable service to a matter of public policy.

The school was founded on the principle of "As the twig is bent," emphasizing the profound impact of early childhood

education on lifelong development. Anderson's vision extended beyond simply providing a safe space for underprivileged children. Her goal was to transform the lives of children through a social and pedagogical framework grounded in equality, care, and empowerment (Prochner, 2009). The kindergarten's mission was rooted in the belief that education during early childhood could yield lasting, positive outcomes for both the individual and society.

Importantly, this initiative was not limited to the needs of children alone—it extended to their families and the broader community. The Woolloomooloo kindergarten aimed to combat poverty, enhance child welfare, reinforce communal values, and promote social equity. It represented a comprehensive approach to early education as both a developmental and a social justice intervention.

The physical environment of the kindergarten was specifically designed to meet the needs of children living in impoverished urban areas. The setting was bright, safe, and provided ample space for children to move freely. The educational philosophy combined Friedrich Froebel's play-based pedagogy with the broader objectives of social reform. As Brennan (1998) analyzes, this kindergarten, along with subsequent initiatives, played a pivotal role in the transition of child care in Australia from philanthropic efforts to publicly supported services, laying the groundwork for 20th-century education policies.

The Woolloomooloo kindergarten stands as a powerful symbol of how early childhood education and social reform can evolve in tandem. It exemplifies the potential of education not only as a tool for individual development, but also as a catalyst for social transformation.

First Chinese Kindergarten (1903)

The first kindergarten in China was founded in 1903 in Wuhan, the capital city of Hubei Province, during the late Qing Dynasty. This school was established as part of the Guimao School System, a reform initiative led by the Qing government that formally integrated kindergartens into the national education framework (Qi & Melhuish, 2017; Zhou, 2016).

This early kindergarten was heavily influenced by Japanese models of early childhood education. The curriculum, instructional strategies, and even the teaching staff were largely imported from Japan, specifically modeled after the Japanese yochien system. The Chinese term *youzhiyuan*—used today to refer to kindergarten—was itself borrowed from Japanese, reflecting the strong cultural and pedagogical exchanges that shaped early Chinese preschool education (Qi & Melhuish, 2017). While the initial structure and pedagogy mirrored Japanese frameworks, significant shifts occurred in the 1920s and 1930s with the introduction of Western educational philosophies. Thinkers such as John Dewey profoundly influenced Chinese educators, encouraging a more child-centered approach and a reevaluation of rigid instructional practices.

During this intellectual transition, Chinese educational reformers began developing hybrid curricula that combined elements of traditional Chinese philosophy with progressive Western pedagogical methods (Qi & Melhuish, 2017; Tillman, 2013). The kindergarten in Wuhan thus became a site of educational experimentation, balancing respect for cultural heritage with the pursuit of modernization and global engagement.

The founding of this kindergarten must be understood not only in educational terms but also as a political and ideological statement. For reform-minded intellectuals and policymakers of the time, early childhood education represented a critical strategy for integrating children into an evolving, modern Chinese society. This signified a broader understanding of education as both an individual

developmental tool and a catalyst for collective national transformation (Qi & Melhuish, 2017; Liv et al., 2016).

In this context, the 1903 Wuhan kindergarten stands as a landmark in the institutionalization of early childhood education in China. It also symbolizes the central role education played in China's broader modernization efforts at the turn of the 20th century.

First Chilean Kindergarten (1906)

The first kindergarten in Chile was opened in 1906 in the capital city of Santiago within the Escuela Normal. Since its foundation, it has provided education under the leadership of Leopoldina Maluschka, an educator (Cárcamo, 2018; Escudero, 2011). One of the founding aims of the kindergarten was to support early childhood education to promote moral and social development. In addition, a system was created in which not only cognitive development but also emotional and social values were emphasized in education.

When the kindergarten was first established, it served a small number of students due to its limited spatial potential. In addition, it started to serve children living in poor neighborhoods and conducted trainings to achieve social equality in Chile. The impact of this initiative was not only on the students, but also on the teacher training process. With the establishment of the preschool, special courses for prospective teachers were opened and preschool education programs were developed. This led to the institutionalization of preschool teaching in Chile.

These developments were interrupted by the onset of the economic crisis in Chile in 1914, and many educational institutions (including preschools) had to be closed (Cárcamo, 2018). Despite all these difficulties, the first kindergarten opened in Santiago contributed greatly to the historical development of preschool education in Chile.

Maria Montessori's Casa dei Bambini (1907)

Casa dei Bambini, also known as the “Children’s House,” was opened in 1907 in the San Lorenzo district of Rome, the capital of Italy. Maria Montessori (1870–1952) is known as both an educator and a physician, and she developed an educational philosophy under the name of the Montessori method (Foschi, 2008). Montessori initially opened this educational institution, which she implemented together with her educational philosophy, for poor children who did not have any mental or physical disabilities. The learning environment was arranged to allow children to make free choices, monitor their own mistakes, and learn at a pace appropriate to their individual development. With this approach, she departed from the traditional teacher-centered and experience-distant system of the time, becoming a pioneer of child-centered education.

When examining the spatial and physical characteristics of educational institutions organized according to the Montessori educational philosophy, they are equipped with furniture, shelves, and play materials at a size and height accessible to children. Areas for free activities have been created within the spaces, aiming to foster children's sense of independence and responsibility. Montessori’s educational methods also include specially designed materials based on children's experiences of scientific observation. At the core of these methods and materials lie the principles of allowing children to explore freely, respecting individual differences, and enabling them to manage their own learning processes (Foschi, 2008; Zakir, 2019). According to the Montessori philosophy, teachers are not defined as figures who transmit knowledge to children but rather as observers who guide their developmental process (Figure 11).

Figure 11. Casa dei Bambini



Reference: Massa, 2024; Roma, 2025

Casa dei Bambini quickly attracted great international interest, and as a result, the Montessori educational philosophy gained a place not only in Europe but also in countries across America, Asia, Africa, and many other regions.

First Indian Kindergarten (1910)

The kindergarten named Dakshinamurti Balmandir holds the distinction of being the first kindergarten established in India, founded in 1910 in the city of Bhavnagar. The founder of the kindergarten was educator and social reformer Gijubhai Badheka, who made a revolutionary contribution to early childhood education in India through this institution. Maria Montessori's educational philosophy influenced many countries, and India was among them. Badheka integrated Montessori's educational approach into the kindergarten by reproducing her materials using locally available resources. Additionally, similar to the Montessori philosophy, the kindergarten adopted a curriculum based on play-based learning, which allowed children to make free choices and supported their

individual development (Tschurenev, 2018). The architectural design of the school was also arranged with open play and exploration areas that were appropriate for the physical and pedagogical development of children.

With its establishment, the Dakshinamurti Balmandir kindergarten not only supported the education and development of children but also contributed to the advancement of social reforms in India. Badheka, by placing particular emphasis on the education of girls, helped to instill nationwide awareness of the societal benefits of educating children from an early age. In his work, he also encouraged the participation of women in professional life by promoting their involvement as teachers (Bagchi, 2014).

In addition to facilitating these reforms, Badheka contributed to the modernization of India's traditional education system, the dissemination of Montessori pedagogy, and the institutionalization of child-centered education (Rathore, 2022).

Ultimately, the school stood not only as a pioneer in early childhood education but also as a model of how culturally adapted modern education could coexist with local traditions. Dakshinamurti Balmandir's legacy continues to resonate as a testament to the transformative potential of inclusive, child-centered learning in shaping a progressive educational and social framework (Tschurenev, 2018; Bagchi, 2014; Rathore, 2022).

The Emergence and Early Development of Kindergarten in the Ottoman Empire

The institutional introduction of early childhood education in the Ottoman Empire occurred as a result of the sociocultural and educational reforms that followed the Second Constitutional Era. The reinstatement of the 1876 Constitution in 1908 facilitated the implementation of Western educational models, and as women

began to gain greater visibility in the public sphere, kindergartens emerged as part of this broader reform agenda (Akyüz, 2023).

During this period, the educational philosophies of Western European theorists such as Friedrich Froebel, Maria Montessori, and Johann Heinrich Pestalozzi were adopted by Ottoman intellectuals. These philosophies emphasized a holistic approach to child development, integrating physical, mental, and emotional growth. Consequently, the first early childhood institutions were established in the empire based on these pedagogical principles (Demirtaş & Arı, 2015). Table 2 summarizes the names, founding years, and cities of the first kindergartens established in the Ottoman Empire.

Table 2. The First Kindergartens Established in the Ottoman Empire

No	Name	Year	Location
1	Bayezid Kindergarten / Bayezid Ana Mektebi	1909	İstanbul
2	Ravza-i Sıbyan Children's Garden / Ravza-i Sıbyan Çocuk Bahçesi (1909)	1909	Selanik
3	Erenköy Valide Mektebi Ana Sınıfı	1913	İstanbul
4	Osmanlı Çocuk Bahçesi	1913	İstanbul
5	İzmit Ana Mektebi	1914	İzmit
6	Hadika-i Maârif Ana Sınıfı	1914	İzmir
7	Yeni Mektep Çocuk Yuvası	1915	İstanbul
8	Menba-i Füyuzat Anaokulu	1910s	İzmir
9	Şark Mektebi Anaokulu	1910s	İzmir
10	Beşiktaş İttihat ve Terakki Ana Sınıfı	1915	İstanbul

Reference: Bektaş, 2025

Bayezid Kindergarten, 1909 (Bayezid Ana Mektebi)

The first privately established kindergarten by Muslims in Turkey was opened in 1909 by Müzeyyen Cemal Hanım in the Bayezid district of Istanbul (Ercoşkun, 2021). The application submitted to the Ministry of Education was approved on February 17, 1909, and the school began operating the same year in a mansion owned by Haydar Efendi. Female educators were employed at the institution, where the educational approach focused on children's development through play, music, nature observation, and gardening activities. In terms of spatial design, the school prioritized natural lighting, open play areas, and classrooms arranged to support group activities and free movement.

Ravza-i Sıbyan Children's Garden, 1909 (Ravza-i Sıbyan Çocuk Bahçesi)

Established in 1909 within the Ravza-i Sıbyan School in Thessaloniki, this kindergarten represents one of the first state-supervised early childhood education initiatives in the Ottoman Empire. Following Kâzım Nami Duru's observations of Froebelian schools in Pest, the program was founded upon Froebel's educational philosophy. Due to a shortage of qualified teachers, two Jewish women graduates of the Alliance Israélite School were appointed to teach, and Kâzım Nami personally trained them in the core principles of Froebelian pedagogy (Türk, 2011). However, the school was forced to close shortly afterward due to the outbreak of the Balkan Wars.

Erenköy Valide School Kindergarten, 1913 (Erenköy Valide Mektebi Ana Sınıfı)

The kindergarten established in Istanbul's Erenköy district in 1913 was one of the pioneering institutions founded through female entrepreneurship and supported by private funding. The educational program included music, art activities, handicrafts, and storytelling.

Based on Froebelian pedagogy, this approach embraced a child-centered, play-based learning model (Karakaş & Demir, 2014). Classrooms were equipped with tools and materials specifically designed to be accessible to children.

Ottoman Children's Garden, 1913 (Osmanlı Çocuk Bahçesi)

This private kindergarten, established in 1913 by Hasan Tahsin Bey and Mustafa Celal Bey, was one of the early educational institutions in the Ottoman Empire to adopt Friedrich Froebel's pedagogical approach directly. The curriculum was designed to include play-based learning, nature observation, handicrafts, and garden activities, all aligned with Froebelian principles. The classrooms were furnished with materials imported from Europe, making the institution one of the most modern early childhood education environments of its time (Ercoşkun, 2021).

İzmit Kindergarten, 1914 (Ana Mektebi)

This kindergarten was established in 1914 in İzmit, during the tenure of Kâzım Nami Duru as the Director of Education. Initially, instruction was carried out by an Armenian female teacher; later, a Turkish teacher was appointed to the position (Türk, 2011).

Hadika-i Maârif School Kindergarten, 1914 (Hadika-i Maârif Mektebi Anasınıfı)

This class, one of the earliest examples of kindergarten established in İzmir, functioned as an extension of the Hadika-i Maârif School. A one-year preschool education program was implemented, aiming to equip children with social and cognitive skills prior to primary education. Dedicated classrooms and play areas were organized within the existing school building to accommodate the needs of young children (Türk, 2011).

Yeni Mektep Children's Home, 1915 (Yeni Mektep Çocuk Yuvası)

Established by the educator Mustafa Satı Bey, this institution presented a comprehensive model that integrated the educational philosophies of Pestalozzi, Froebel, and Montessori. In line with Satı Bey's approach—based on individual attention and a reward system—each child was provided with the opportunity to develop freely (Ünal, 2021). Classrooms were furnished according to the children's height, and materials were arranged to be freely accessible. Additionally, a Dârülmürebbiyât (a training school for female teachers) was founded within the same institution.

Menba-i Füyuzat Kindergarten, 1910s (Menba-i Füyuzat Anaokulu)

In this kindergarten established in İzmir, a two-year early childhood education program was implemented. The first year focused on play and the development of basic skills, while the second year emphasized preparation for primary school (Türk, 2011). Classrooms were organized by age groups, and the facility included gardens that allowed for outdoor activities as well as multipurpose halls.

Şark Mektebi Kindergarten, 1910s (Şark Mektebi Anaokulu)

In this institution, which bore the traces of reform pedagogy, a two-year educational model was implemented, supporting individual development in age-appropriate classrooms. A play-based curriculum was developed, incorporating activities such as handicrafts, singing, and nature observation (Demirtaş & Arı, 2015).

Beşiktaş İttihad and Terakki School Kindergarten, 1915 (Beşiktaş İttihat ve Terakki Mektebi Ana Sınıfı)

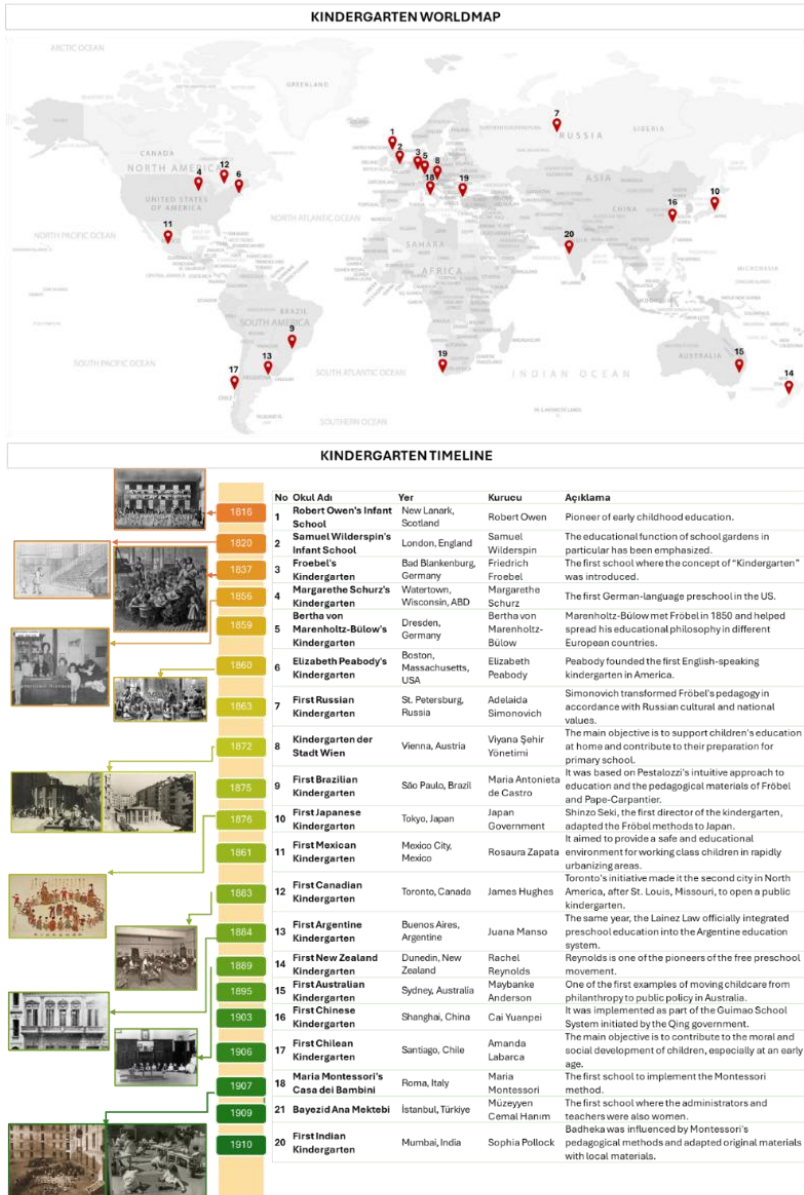
This kindergarten, established in line with the educational policies of the Committee of Union and Progress (İttihat ve Terakki

Cemiyeti), was equipped with modern tools and materials. In accordance with Froebelian pedagogy, play, music, garden activities, and gymnastics formed the core components of the educational program (Ercoşkun, 2021). The school soon became one of the key symbols of modern preschool education in Istanbul.

Conclusion and Discussion

In conclusion, the historical development of kindergartens began in 1837 with the establishment of the first “Kindergarten” by Friedrich Froebel in Germany. This model rapidly spread from Europe to America, and later to Asia, Australia, and Latin America. In the late 19th and early 20th centuries, countries such as Japan, China, India, Argentina, Mexico, and Australia founded their first Froebelian or Montessori-inspired kindergartens, adapting these educational models to their respective socio-cultural contexts. In the Ottoman Empire, the concept of the modern kindergarten emerged during the Second Constitutional Era, with the first officially recognized kindergarten opening in Istanbul in 1909. During the Republican period, a state-supported, widespread preschool education policy was adopted. Throughout this historical trajectory, kindergartens have become key components of pedagogical transformation as well as architectural and societal modernization (Figure 12).

Figure 12. Historical Development of the First Kindergartens



In the case of Japan, kindergartens established after the Meiji movement attempted to incorporate Froebel's educational models into their own education system. However, the hierarchical and disciplined structure of Japanese society's education system presented contradictions with Froebel's philosophy. At this point, the kindergarten education system was oriented toward both individual development and the cultivation of ideal citizens for the nation-state.

The situation in Russia was somewhat different. Kindergartens initially implemented Froebel's educational philosophy, but over time, the collectivist, disciplined, and moral dimensions of socialist ideology became more dominant. Similarly, in Latin American countries such as Mexico and Argentina, the educational philosophies of European figures like Froebel and Pestalozzi were adopted. However, these models were modified by state policies and socio-cultural characteristics with the aim of reducing class-based disparities among families, including children from poor families in education, and supporting social reforms.

Apart from Froebel, the educational philosophy of Maria Montessori, a pioneering figure in the foundation of alternative models, was introduced to India under the leadership of Gijubhai Badheka. In the Ottoman Empire, kindergartens established during the Second Constitutional Era and the Republican period were founded within a Western-oriented ideological framework. Institutions supported particularly by the Ministry of Education (Maarif Nezareti) were not only designed to provide early education for children but were also regarded as instruments of social policy aimed at strengthening the role of women in society.

When examining the emergence and historical development of kindergartens, studies have shown that the social status of families directly influenced this process. Educational reforms that began in

19th-century Europe and later spread globally were often initiated with the aim of educating children from families with high income levels and favorable socio-economic conditions. However, this generalization does not apply to all early kindergarten establishments. Some educators were also motivated by the goal of protecting children from low-income families and integrating them into society.

For example, the kindergarten (Maison Royale de Saint-Louis) established in France under the leadership of Madame de Maintenon was opened for the daughters of noble families with limited financial means. On the other hand, the Infant School founded by Robert Owen in England aimed to provide a safe and productive educational environment for the children of the working class and low-income families. Similarly, the kindergartens founded by Samuel Wilderspin were mainly targeted at the children of lower-class families, aiming to shape them into individuals compatible with the social order. In Russia and China, the situation was somewhat different. Kindergartens were established in response to the educational demands of the emerging middle-class families. These countries, with their strict rules and policies, sought to raise children as individuals who conformed to the requirements of the modern state.

In conclusion, the social status and socio-economic conditions of families have influenced both the pedagogical model and the spatial structure of the education their children received. Thanks to educators who recognized this reality and envisioned educational equality across status and economic levels, all children were given the opportunity to access education under equal conditions.

From the establishment of the first kindergartens in the world (19th–20th centuries) to the present day, a process characterized by both continuity and transformation can be observed. The

pedagogical approaches developed by pioneers such as Fröbel, Montessori, Pestalozzi, Owen, and Wilderspin laid the foundations of modern education, and many of their principles are still valid today. For example, Fröbel's "children's garden" philosophy—particularly the principle of learning through play—directly aligns with the "play-based learning" approach included in today's curricula. Similarly, Montessori's emphasis on freedom in the child's physical and cognitive development and her environment-based learning methods have been integrated into the educational systems of both public and private schools.

In addition to all this information, contemporary kindergarten education systems have diverged from historical examples to become more comprehensive, intercultural, technology-oriented, and multidisciplinary. While early kindergarten education systems were generally designed for a specific social class or group, contemporary kindergartens emphasize values such as universal access, inclusivity, and gender equality. Topics that have been added to kindergartens today include STEM education, digital literacy, sustainability, and ecological awareness. This demonstrates that the core pedagogical spirit of the first kindergartens has been preserved, but reinterpreted in accordance with the needs of the present era. Beyond this, many of today's kindergarten curricula still reflect Froebel's "learning through play," Montessori's "prepared environment," Pestalozzi's "sensory intuition," and Owen's focus on "moral development of children."

In the context of the Ottoman Empire and Turkey, the Second Constitutional Era, which marked a significant step toward modernization and Westernization, stands out as one of the primary factors influencing the preschool education system. Since the establishment of the first kindergarten in 1909 within the structure of the Hususi Ana Mektebi (Private Kindergarten School), preschool education in Turkey has developed considerably in both pedagogical

and institutional terms. Today, preschool education in Turkey is governed by curricula and education policies determined by the Ministry of National Education (MEB). According to MoNE's planning, children between the ages of 36 and 72 months may attend kindergarten, and different models are offered depending on age groups. The system is being expanded systematically, based on scientific foundations regarding the effects of early education on children's cognitive, emotional, and social development.

In present-day Turkey, teachers assigned to work in kindergartens are appointed by the Council of Higher Education (YÖK). These teachers are trained in the departments of "Preschool Education" within universities, where they receive instruction in pedagogical formation, practical training, and related areas.

In recent years, various projects have been implemented in Turkey with the aim of ensuring that all children receive preschool education. Efforts to make preschool education compulsory for children in the five-year-old age group are ongoing, and the goal of achieving equal opportunities in education is also being pursued. As in many parts of the world, Turkey includes families with middle and low income levels as well as disadvantaged regions. Therefore, policies such as "mobile preschool classrooms," "transported education," and "family support programs" are being implemented to provide education to children living in these areas and from these families.

To summarize, it is evident that the movements which brought the concept of kindergarten to life on a global scale in the 19th century, along with the ideologies of many pioneering educators, continue to maintain their relevance today. These pedagogical approaches and spatial elements have been influenced over time by technological developments and social differentiation. When examining examples from Europe to America, and from Asia to Africa and Latin America, it becomes clear that diverse socio-

cultural conditions have played a defining role in shaping early childhood education environments.

As a result of this study, it has been observed that early childhood education is not solely a matter of pedagogy, but also has a significant impact on the design of architectural spaces and on how those spaces are sustained through their users and the ideas they embody.

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CHAPTER 3

A BIBLIOMETRIC ANALYSIS OF ACADEMIC STUDIES ON CLIMATE CHANGE RESILIENCE BASED ON SCOPUS DATA

AYŞENUR BAYSAK¹

MURAT DAL²

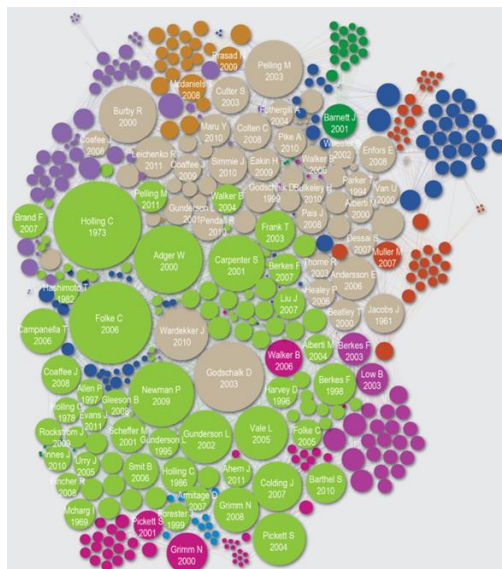
INTRODUCTION

Climate change is currently regarded not only as an environmental issue but also as a multidimensional global crisis with economic, social, and political implications. Strategies developed in response to this crisis are generally addressed under two main categories: mitigation and adaptation. However, in recent years, a more comprehensive concept—resilience—has come to the forefront beyond these two approaches. Resilience refers not only to the capacity of systems to adapt to changing climatic conditions but also to their preparedness for such changes, their ability to absorb impacts, and their capacity to recover quickly after crises. This multidimensional structure is often conceptualized through models that highlight adaptive capacity, flexibility, and socio-ecological feedback mechanisms (Meerow, Newell , Stults, 2016).

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Figure 1. Elements of urban resilience including diversity, flexibility, equity, and polycentric governance



Source: Adapted from Meerow, Newell, and Stults (2016).

In the context of climate change, resilience should be considered alongside mitigation and adaptation strategies, as these three concepts form complementary components of a holistic approach (Kirby, 2020). Climate change resilience is a multidimensional process that encompasses both the adaptive capacity and the resistance and recovery potential of systems in the face of climatic threats (Serrao-Neumann, Crick, Harman, & Schanze, 2015). Resilience requires the integrated consideration of not only environmental systems but also economic and social structures within the context of climate change (Ostadtaghizadeh, Ardalan, Paton, & Jabbari, 2016).

The concept of climate change resilience is strongly linked to fields such as disaster risk management, sustainable development, infrastructure planning, and social vulnerability. For this reason, resilience has become a strategic focal point located at the intersection of various disciplines and has attracted increasing research attention. The concept of resilience emerges as a strategic

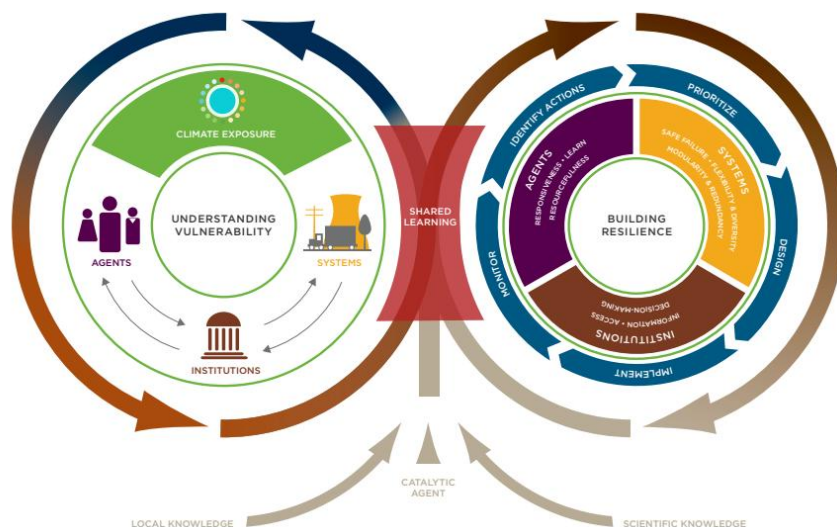
tool of analysis, particularly in areas such as urban planning, disaster management, and the protection of social ecosystems (Elmqvist, ve diğerleri, 2019). Since 2015 in particular, a remarkable increase has been observed in the number of publications on this topic in the academic literature. A bibliometric analysis conducted through the Web of Science database reveals a notable rise in studies that address climate change and local governance together, and indicates that research in this area is becoming increasingly diverse (Koçar Uzan, 2025).

Research on climate change resilience has accelerated significantly since 2015, particularly concentrating on themes such as sustainability, disaster risk reduction, and the protection of vulnerable groups (Fernández-Llamazares, Bennett, Díaz-Reviriego, Brondizio, & Reyes-García, 2021). This growing interest is not only limited to an increase in the number of publications but also enables the conceptual redefinition of resilience and its transformation into applicable strategies across various sectors (Wang et. all, 2023). In this study, academic publications listed in the Scopus database under the title “climate change resilience” were analyzed using bibliometric methods. The aim is to identify the structural characteristics of scientific knowledge produced in this field, analyze trends, and determine potential areas for collaboration. Bibliometric analyses contribute to understanding the direction of research fields by objectively revealing the structural patterns, thematic concentrations, and collaboration networks of scientific production (Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021). The analysis, based on parameters such as publication year, country, institution, author, journal, and keywords, demonstrates the themes around which the concept of resilience has evolved and highlights its interdisciplinary connections.

The concept of climate change resilience offers a multidisciplinary field of inquiry that encompasses not only environmental systems but also social structures, economic processes, and governance mechanisms. For communities in particularly vulnerable regions, resilience strategies are of vital importance, and their success emerges as a key determinant in reducing climate-related risks. These strategies are especially critical

in enhancing the capacity of socioeconomically vulnerable populations to cope with the risks posed by climate change (Sharifi, 2016). The concept of resilience involves not only reducing the impacts of climate-related disasters but also strengthening the preparedness and recovery capacity of societies (Rana, 2020). A model that illustrates these dynamics in detail is the Climate Resilience Framework (CRF), developed by ISET-International. It demonstrates how agents, institutions, systems, and climate exposure interact through shared learning to build adaptive capacity and long-term resilience (Transition-International, 2012). In this context, addressing climate change requires not only technological solutions but also the development of socially cohesive mechanisms and policies rooted in local knowledge. The literature shows that the role of local actors in developing strategies to enhance societal resilience against climate change is becoming increasingly prominent (Nalau, Preston, & Maloney, 2015).

Figure 2. Climate Resilience Framework showing the interaction of agents, institutions, systems, and climate exposure through shared learning



Source: Adapted from Institute for Social and Environmental Transition-International (2012).

Community-based resilience strategies should incorporate not only physical infrastructure but also social networks, local knowledge systems, and participatory governance structures (Meerow, Newell, Stults, 2016). For resilience strategies to succeed, attention must be paid not only to technical solutions but also to social factors such as community participation and the integration of local knowledge systems (Agbehadji, Schütte, Masinde, Botai, & Mabhaudhi, 2024). Resilience must be supported not only by physical infrastructure but also by policies sensitive to inequality dynamics such as social justice, inclusivity, and access to resources (Chelleri, Waters, Olazabal, & Minucci, 2015).

In the relevant literature, it is observed that the conceptual boundaries of climate change resilience have evolved over time and diversified further through interdisciplinary research. A bibliometric analysis of approximately 120,000 climate change publications produced between 2001 and 2018 shows that research foci have shifted from physical sciences toward climate technologies and policy studies (Fu & Waltman, 2021). Academic studies on climate change increasingly concentrate on themes such as governance, climate justice, adaptation, sustainability, and resilience, adopting interdisciplinary approaches in these areas (Yıldız & Demir, 2025). While resilience-based research is particularly prominent in fields such as environmental sciences, urban studies, and disaster management, it is also encountered in various disciplines including public health, education, public administration, and economics. In this context, systematically analyzing trends in the literature not only maps past studies but also contributes to shaping future scientific production and policymaking processes. Bibliometric analyses not only provide a mapping of the current literature but also assess research trends, thereby contributing to the formation of academic agendas (Zhang, Li, Liu, & Zhao, 2023). At this point, bibliometric analysis serves as a robust method for objectively revealing the structural dynamics and research orientations of the literature.

The concept of climate change resilience is being applied more widely across various sectors and scales. It is referenced in numerous fields, ranging from urban infrastructure planning and agricultural production systems to public health policies and water

management, and institutional strategies are being reshaped within this framework. In the agricultural sector, resilience to climate change aims not only to ensure the sustainability of production systems but also to protect the livelihoods of rural communities, particularly by addressing vulnerability and enhancing adaptive capacities against climate impacts (Ali & Erenstein, 2017). This multidimensional use has enabled the concept to resonate in both local and global contexts and has provided a basis for increasing interdisciplinary collaborations. Resilience refers to the capacity of socio-ecological systems to absorb shocks, reorganize, and maintain their functionality in the face of climate change (Folke, 2006). The impacts of climate change on ecosystems and sustainability, especially in fragile areas such as rangelands, necessitate the integrated consideration of resilience, adaptation, and long-term management strategies (Putra, Gopar, Surachman, & Darmawan, 2025). Resilience research related to climate change informs interdisciplinary applications in a wide range of fields, from environmental governance to disaster planning (Bahadur, Ibrahim, & Tanner, 2010). Climate change resilience is directly linked to the capacity of cities to build flexibility in the face of current shocks and future uncertainties (Leichenko, 2011).

The bibliometric analysis method used in this study enables a systematic examination of prominent trends in the literature, collaborations among authors and institutions, the most frequently preferred journals, and key concepts. In this analysis, Scopus—one of the most widely recognized academic databases worldwide—was utilized. Scopus's broad data coverage, citation tracking capability, journal quality, and indexing standards are among the key factors that enhance the reliability and validity of this study. Due to its extensive scope and accurate citation data, Scopus is one of the most commonly used databases in bibliometric research (Yin, Gao, Song, & Liu, 2023). Accordingly, this study not only reveals a quantitative overview of the resilience literature but also aims to make a strategic contribution toward mapping the scientific landscape of the field.

MATERIAL AND METHOD

Bibliometrics is an interdisciplinary field of research that analyzes the quantitative features of scientific publications and aims to reveal the structural characteristics of the literature. This method systematically evaluates the development of scientific production by examining the types of publications produced on a specific topic, their distribution over time, the authors, institutions, countries, and keywords associated with them. Bibliometric analyses conducted on art gardens indicate that this field has developed as a research area based on environment, culture, and creativity, and has attracted increasing interdisciplinary interest (Baysak & Dal, A bibliometric analysis of academic studies on the art garden, 2025a). This method, which treats the literature itself as data, provides an opportunity to analyze both the trends in scientific knowledge production and the forms of academic collaboration. Bibliometric analysis objectively reveals the structural features of research domains by modeling their temporal evolution, institutional interactions, and conceptual proximities (Aria & Cuccurullo, 2017).

Bibliometric analysis is particularly useful for identifying the transformation of scientific activity in a specific field over time, as well as for determining leading authors, highly cited works, and prominent journals. Additionally, by evaluating citation counts, it helps measure the scientific impact level and assess the visibility and prevalence of research domains. In this context, the networks among published works can be visualized through graphs and network analyses, making the dynamics of academic production more visible. Bibliometric analysis is not limited to assessing publication or citation counts; it also reveals the temporal transformation of research domains, thematic clusters, and interdisciplinary connections (Dal & Burkut, Ekolojik mimari ve eko-mimarlık üzerine sistematik literatür taraması ve bilimsel haritalar, 2023).

Today, bibliometric analyses are regarded not only as tools for evaluating scientific trends but also as strategic instruments that guide decision-makers in developing research policies, identifying priority topics, and allocating resources effectively. This method plays a strategic role in shaping research agendas and enables

researchers to focus on high-priority topics and identify future research gaps (Bekler, Ay, Dal, & Bekler, 2024). The co-occurrence frequency of keywords is a significant indicator for analyzing the evolution of research themes over time. In this way, interdisciplinary intersections and thematic clusters can be identified, allowing the development of the field to be evaluated in a holistic manner.

The application of bibliometric methods requires access to reliable and comprehensive databases. The most commonly used data sources in such analyses include Web of Science, Scopus, Dimensions, and Google Scholar. In this study, the data source was Elsevier's Scopus database. Scopus offers significant advantages in terms of analytical validity due to its wide content coverage, diversity of publication types, reliable citation data, and high indexing standards. With its comprehensive data structure covering various disciplines and its up-to-date content delivery, Scopus enables the global-scale analysis of scientific production (de Granda-Orive, Alonso-Arroyo, & Aleixandre-Benavent, 2011).

In this study, academic publications focusing on the topic of "climate change resilience" were analyzed using bibliometric methods. The data collection process was carried out through the Scopus database on May 18, 2025. During the search, the keywords "climate change resilience" or "climate change resilience" were used across all fields, and duplicate records were eliminated. No publication year restriction was applied, allowing for a comprehensive evaluation of the historical development of the literature. As in previous bibliometric studies, indicators such as publication year, document type, author, and keyword were used in the analysis, and all data were obtained from the Scopus database (Baysak & Dal, A bibliometric analysis of academic studies on the SCAMPER method, 2025b).

The collected data were analyzed using various bibliometric indicators such as distribution by publication year, document type, author and institutional productivity, country contributions, journal preferences, and keyword frequency. Bibliometric analyses not only model academic collaboration networks but also define thematic clusters formed around specific topics, thereby revealing the

structural mapping of scientific knowledge (Dal & Karataş, Earthquake research bibliometrics in architecture, 2023). Furthermore, the relationships between publication types were examined, and inferences were made regarding collaboration patterns and research trends. In this way, the structural characteristics of academic production on climate change resilience were presented in detail.

The aim of this study is to systematically examine the climate change resilience literature using bibliometric analysis methods and to reveal the current state, trends, and potential development areas of the scientific knowledge produced in this field. The findings are intended to serve as a guiding resource for both researchers and decision-makers. In addition, this analysis aims to generate comprehensive insights into interdisciplinary collaboration opportunities and future research gaps. Bibliometric indicators not only help determine the direction of scientific production but also play a guiding role for policymakers in identifying strategic priorities (Rafols, Porter, & Leydesdorff, 2010).

FINDINGS

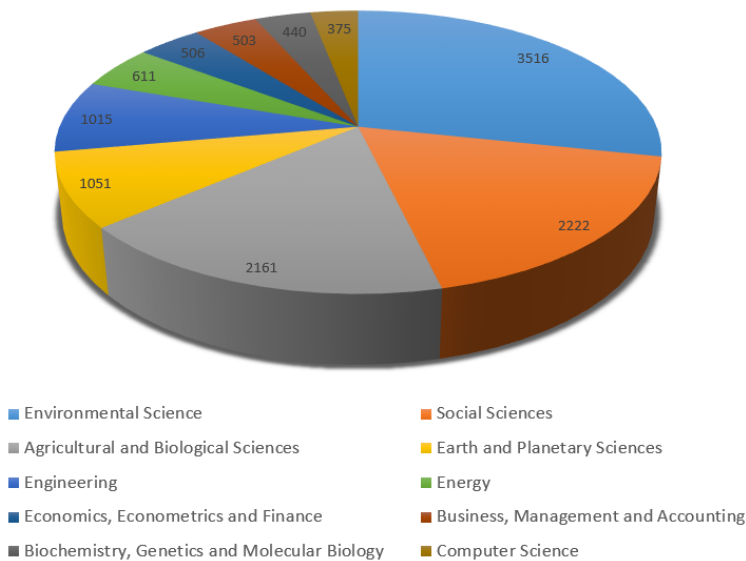
A total of 6,827 academic publications were identified in a search conducted on May 20, 2025, using the keywords “climate change resilience” and “climate change resilience” in the Scopus database. This result indicates a growing scientific interest in the concept and shows that resilience-themed studies within the context of climate change have reached a significant volume. The search was conducted across all fields and was not limited to title, abstract, or keywords. The results provided comprehensive data for evaluating key bibliometric parameters such as publication year, author, journal, keywords, and citation count.

The distribution of academic studies on climate change resilience by subject area reflects the multidisciplinary nature of research in this field. As shown in Figure 3, the majority of publications are concentrated in the field of Environmental Science. This is followed by Social Sciences, Agricultural and Biological Sciences, and Earth and Planetary Sciences. This distribution demonstrates that climate change resilience is not considered solely

an ecological issue, but rather a comprehensive research topic encompassing social, economic, and governance dimensions as well.

The diversity of subject areas in which the publications are distributed also highlights the strength of scientific collaboration opportunities and interdisciplinary approaches. As Sharifi (2016) emphasizes, strategies aimed at enhancing societal resilience require not only technical infrastructure but also simultaneous solutions in areas such as socioeconomic conditions, governance mechanisms, and knowledge sharing. Therefore, this diversity of subject areas supports both the breadth of the concept’s theoretical framework and the versatility of its practical applications.

Figure 3. Scopus subject areas on climate resilience



Subject Area	Pubs.
Environmental Science	3516
Social Sciences	2222
Agricultural and Biological Sci.	2161
Earth and Planetary Sciences	1051
Engineering	1015
Energy	611
Economics & Finance	506
Business & Mgmt.	503
Biochem. & Molecular Bio.Biology	440
Computer Science	375

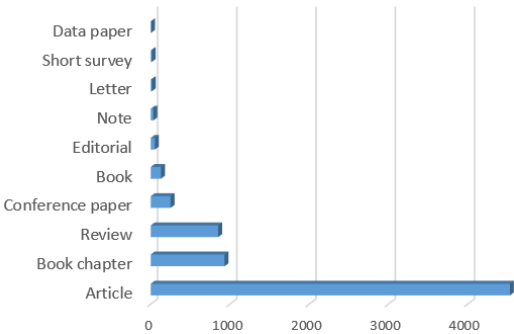
As shown in Figure 4, academic production on “climate change resilience” predominantly occurs through peer-reviewed journal articles. A total of 4,535 articles indicates that this publication type is by far the most prominent in the literature. This is followed by book chapters and review articles, which significantly contribute to strengthening the theoretical foundation of the field and synthesizing existing knowledge.

Although other publication types such as conference papers, books, editorials, notes, letters, and data papers are represented at relatively lower rates, they demonstrate that research activities in this area are carried out across different platforms and scientific formats. This diversity shows that the topic of climate change resilience is not limited to academic journals alone but also emphasizes the growing importance of interdisciplinary knowledge exchange and multifaceted scientific communication.

In this context, the distribution of publication types serves not only as a quantitative indicator but also provides insight into the

dominant knowledge production formats in the literature, the platforms in which they are more visible, and the diversification of research practices.

Figure 4. Document types on climate change resilience



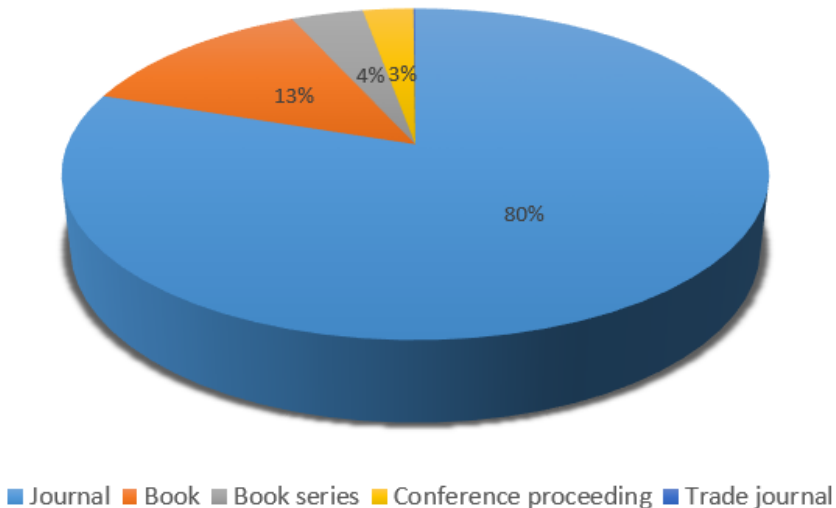
Document Type	Count
Article	4535
Book Chapter	932
Review	852
Conference Paper	251
Book	130
Editorial	53
Note	34
Letter	14
Short Survey	13
Data Paper	5

As shown in Figure 5, the vast majority of scientific publications on “climate change resilience” have been published in peer-reviewed academic journals. With a total of 5,400 publications, journals clearly dominate. This finding reveals that the topic has gained high visibility in the academic community and that systematic scientific production is largely carried out through journal formats.

Books (880 publications) and book series (264 publications) also make significant contributions by shaping the theoretical depth of the subject and providing thematic collections. Conference proceedings serve as rapid channels for disseminating current developments in the field, while trade journals—being more sector-specific—are represented at a rather limited level.

This distribution indicates that the topic of resilience is addressed through both in-depth scientific analyses and comprehensive, book-length studies; however, it is predominantly concentrated in academic journals. The preference for journal-based formats demonstrates that knowledge production in this field is maintained with a strong focus on scientific quality and impact.

Figure 5. Source type distribution on climate change resilience



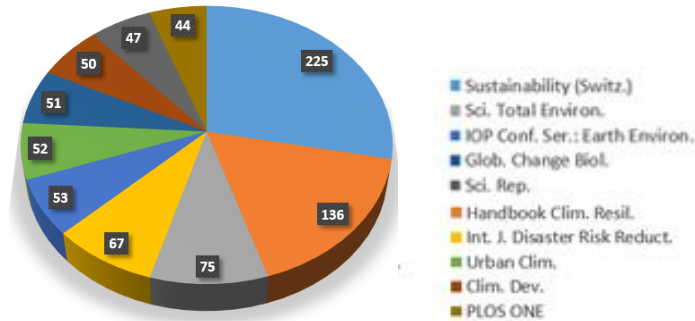
Source Type	Count
Journal	5400
Book	880
Book Series	264
Conference Proceeding	186
Trade Journal	7

As shown in Figure 6, academic publications on climate change resilience are noticeably concentrated in certain journals. At the top of the list is *Sustainability (Switzerland)*, which ranks as the most productive source in the literature with 225 publications in this field. This highlights not only the journal’s focus on the topical relevance of climate resilience but also researchers’ tendency to prefer this platform for publication. *Sustainability* is followed by other prestigious sources such as the multi-volume *Handbook of Climate Change Resilience*, *Science of the Total Environment*—known for its environmental analyses—and the *International Journal of Disaster Risk Reduction*, which emphasizes disaster-oriented research.

What is noteworthy is not only the numerical prominence of these journals but also their role in representing diverse scientific perspectives. The distribution of journal titles indicates that climate change resilience is not merely framed as an environmental issue but is also comprehensively addressed within thematic areas such as disaster management, biological systems, urban planning, climate policy, and development studies. This underlines both the multidisciplinary nature of the topic and the conceptual diversity present in the academic literature.

In this regard, the distribution of journals offers meaningful insights not only in terms of publication frequency but also into interdisciplinary knowledge production methods, institutional publication preferences, and strategic tendencies in climate resilience research.

Figure 6. Top journals publishing on climate change resilience



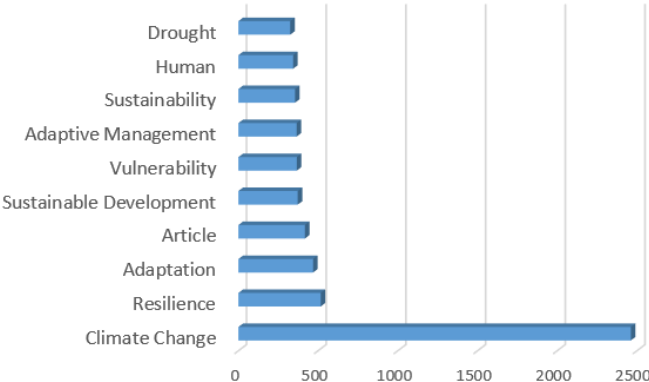
Journal Title	Pub. Count
Sustainability (Switz.)	225
Handbook Clim. Resil.	136
Sci. Total Environ.	75
Int. J. Disaster Risk Reduct.	67
IOP Conf. Ser.: Earth Environ.	53
Urban Clim.	52
Glob. Change Biol.	51
Clim. Dev.	50
Sci. Rep.	47
PLOS ONE	44

As shown in Figure 7, the most frequently encountered keyword in publications on “climate change resilience” is, by far, *climate change* (2462 occurrences). This clearly demonstrates how deeply the concept of resilience is interwoven with climate change and that these two concepts are most often addressed together in scholarly work.

The term *resilience*, ranking second, represents the core focus of the study, while keywords such as *adaptation*, *sustainable development*, and *vulnerability* reflect complementary themes that emphasize the political, social, and environmental dimensions of the subject. Keywords like *adaptive management* and *drought* provide insights into strategic responses to climate change and highlight the key threats being addressed.

This keyword analysis is of critical importance for understanding the thematic focuses, conceptual density, and interdisciplinary connections within the research literature on climate change resilience.

Figure 7. Most frequent keywords in climate change resilience research



Keyword	Count
Climate Change	2462
Resilience	516
Adaptation	468
Article	417
Sustainable Development	372
Vulnerability	366
Adaptive Management	365
Sustainability	355
Human	343
Drought	325

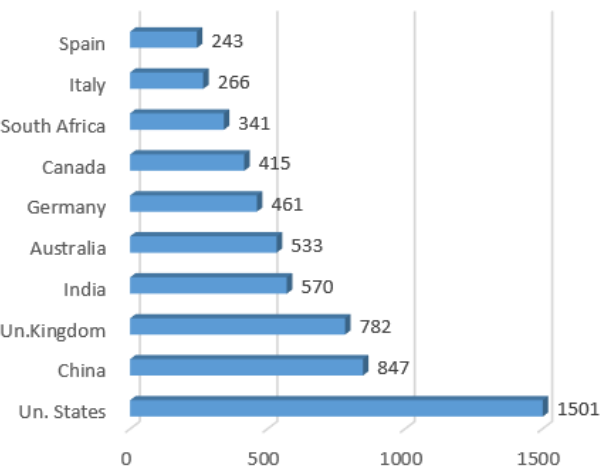
As shown in Figure 8, academic production on climate change resilience is predominantly concentrated in countries located in North America, Europe, and Asia. The United States ranks first with 1,501 publications, clearly leading the field. It is followed by countries such as China, the United Kingdom, and India, which hold a prominent share in the literature due to their strong research infrastructures and the intensive discourse surrounding environmental policies and practices.

Australia, Germany, and Canada stand out for their pioneering policies and academic contributions in combating climate change, while the inclusion of developing countries like South Africa indicates that the topic is being addressed on a global scale. European countries such as Italy and Spain also occupy a significant position in terms of publication output.

This distribution demonstrates that the literature on climate change resilience is not limited to developed countries but also

includes active contributions from nations with diverse geographical, economic, and ecological contexts.

Figure 8. Countries with the highest scientific output on climate change resilience



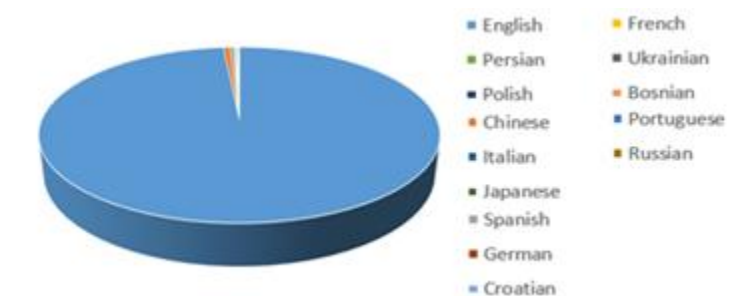
Country/Territory	Pub. Count
United States	1501
China	847
United Kingdom	782
India	570
Australia	533
Germany	461
Canada	415
South Africa	341
Italy	266
Spain	243

As shown in Figure 9, the vast majority of academic publications on climate change resilience are written in English. According to Scopus data, nearly all of the 6,732 publications are in English, reaffirming the status of English as the dominant global language of science. English continues to be the prevailing language in academic research due to its role in generating international impact, reaching broader research communities, and facilitating global knowledge exchange.

Non-English publication languages remain considerably limited. Despite being widely spoken, languages such as Chinese (41 publications) and Spanish (27 publications) have relatively low representation in the scientific literature. Similarly, other major world languages such as French, Portuguese, Persian, German, and Italian are represented by only a small number of publications. Among the least represented languages are Ukrainian, Russian, Polish, Japanese, Croatian, and Bosnian, each with just one publication.

This distribution reveals linguistic inequalities in the circulation of academic knowledge and reflects structural limitations that restrict the global visibility of locally produced research. Although many studies are conducted in developing countries, they often remain confined to non-English languages, preventing them from gaining sufficient presence in global literature. This highlights, once again, the importance of multilingual academic participation and inclusive knowledge sharing in addressing a global issue such as climate change.

Figure 9. Language distribution of climate change resilience publications



Language	Count
English	6732
Chinese	41
Spanish	27
French	11
Portuguese	9
Persian	4
Italian	4
German	3
Ukrainian	1
Russian	1
Polish	1
Japanese	1
Croatian	1
Bosnian	1

As shown in Figure 10, the distribution of academic publications on climate change resilience over the years reveals a remarkable increase, particularly after 2015. While the topic was represented by only one publication in 1990 and remained at a low level throughout the 2000s, a sharp upward trend began in 2015. This rise corresponds with both the influence of international policies such as the Paris Climate Agreement and the growing scientific and societal awareness of the climate crisis.

The year with the highest number of publications is 2024, with a peak of 1,308 publications in the literature. It is followed by 2023 (997 publications) and 2022 (885 publications). These figures indicate that academic output on climate change has recently intensified, and that resilience-themed studies have become a central focus in the current research agenda.

In particular, over the past five years, academic interest has not only increased quantitatively but has also deepened thematically due to the influence of political, environmental, and social crises. The rapid growth in publication numbers reflects the widespread adoption of interdisciplinary approaches and signals that the concept of resilience is no longer merely a theoretical framework, but has become a practical and applied policy tool.

Figure 10. Annual distribution of publications on climate change resilience

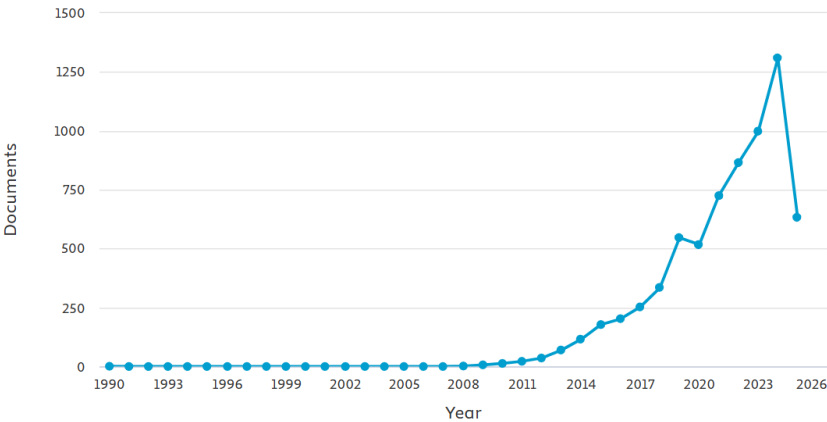


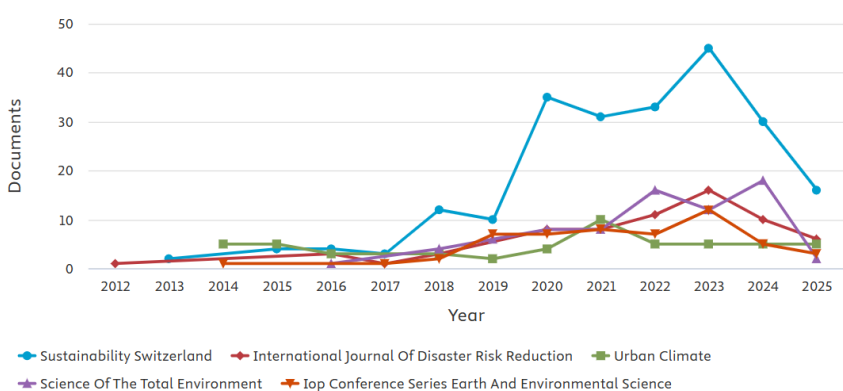
Figure 11 presents a line chart illustrating the distribution of publications on “climate change resilience” over time, specifically across the five most contributing journals. The graph covers the years 2012 to 2025 and visualizes changes in publication trends.

According to the data, *Sustainability (Switzerland)* stands out as the most productive journal in this field. Especially after 2020, there has been a rapid increase in the number of publications, peaking in 2022 with nearly 50 articles. The high publication volume in this journal indicates that the themes of climate change and sustainability are being addressed in an integrated manner and that this platform has become a preferred outlet for researchers.

An upward trend is also observed after 2018 in journals such as *Science of the Total Environment*, *International Journal of Disaster Risk Reduction*, *IOP Conference Series: Earth and Environmental Science*, and *Urban Climate*. The growth in these journals reveals that climate change resilience is gaining attention across diverse disciplines and journal profiles.

Overall, the line chart demonstrates a significant rise in scientific interest in this topic over the past decade, a concentration of that interest in certain journals, and that the period following 2020 represents a critical threshold for academic production in this area.

Figure 11. Annual distribution of publications in top journals on climate change resilience

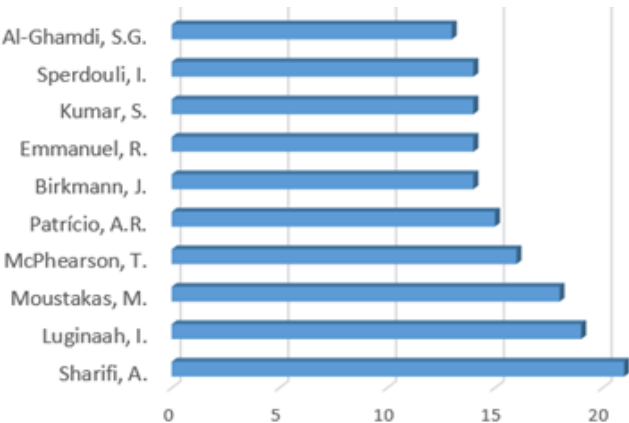


As shown in Figure 12, the most prolific authors in the field of “climate change resilience” are listed. Leading the list is Sharifi, A., with a total of 21 publications, making him one of the most prominent academic figures in the field. He is followed by Luginaah, I. (19 publications), Moustakas, M. (18 publications), and McPhearson, T. (16 publications).

These data are significant in identifying the researchers who have shaped the academic development of the topic. The interdisciplinary work of these scholars extends beyond environmental sciences and contributes to fields such as urban planning, public health, sustainability, and disaster management. This reflects the multidimensional nature of climate change resilience and highlights the inclusive and wide-ranging character of the research landscape. Moreover, the fact that most of the top 10 authors are from different countries indicates that the field is evolving within a global research network and is being studied not only in specific regions but also by researchers from various continents.

Such analyses are important not only for identifying influential scholars in the literature but also for offering valuable insights into potential academic collaborations and emerging research directions.

Figure 12. Most prolific authors in climate change resilience publications



Author	Pub. Count
Sharifi, A.	21
Luginaah, I.	19
Moustakas, M.	18
McPhearson, T.	16
Patricio, A.R.	15
Birkmann, J.	14
Emmanuel, R.	14
Kumar, S.	14
Sperdouli, I.	14
Al-Ghamdi, S.G.	13

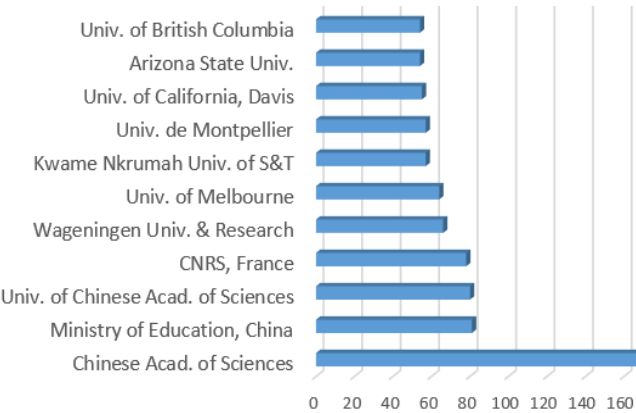
As shown in Figure 13, the institutions that have contributed the most to academic publications on “climate change resilience” are listed. Leading the list is the Chinese Academy of Sciences, which stands out as the most active research institution in this field with a total of 168 publications. Two other China-based institutions—the Ministry of Education and the University of Chinese Academy of Sciences—also rank among the top three, reinforcing China's leadership in this area of research.

Other institutions with high publication output include CNRS from France, Wageningen University & Research from the Netherlands, and the University of Melbourne in Australia. The list also features universities from countries such as Canada, Ghana, Australia, and the United States, indicating that climate change resilience is addressed on a global scale and that interdisciplinary academic collaborations are strong and diverse.

These institutions play a key role in shaping the literature in the field and directing future research trends. The increasing

diversity of institutional contributions also highlights the growing importance attached to the topic and reflects a strengthening link between academic communities and policy makers.

Figure 13. Most active institutions publishing on climate change resilience



Affiliation	Count
Chinese Acad. of Sciences	168
Ministry of Education, China	81
Univ. of Chinese Acad. Sci.	80
CNRS, France	78
Wageningen Univ. & Res.	66
Univ. of Melbourne	64
K. Nkrumah Univ. of S&T	57
Univ. de Montpellier	57
Univ. of California, Davis	55
Arizona State Univ.	54
Univ. of British Columbia	54

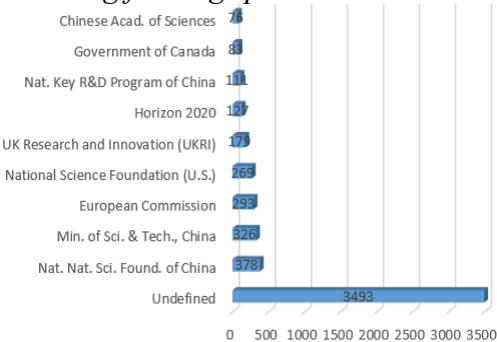
As shown in Figure 14, the most frequently encountered funding sources in research on “climate change resilience” are listed. At the top of the list are publications with undefined funding sources, indicating that a large number of articles (3,493) in bibliometric databases do not include funding information. This highlights that funding details are not always systematically reported in academic publications.

Among the defined sources, funding agencies based in China stand out. The National Natural Science Foundation of China (378 publications) and the Ministry of Science and Technology of China (326 publications) are among the most prominent supporters of research in this area. This reflects China’s strong academic investment in addressing climate change.

European Union funding bodies such as the European Commission (293 publications) and the Horizon 2020 Programme (127 publications), along with the U.S.-based National Science Foundation (269 publications), also make significant contributions. Additionally, UK Research and Innovation (179 publications), the Government of Canada, the Chinese Academy of Sciences, and Wageningen University are notable institutional funders.

This distribution demonstrates that research on climate change resilience is supported not only through individual or institutional efforts, but also via large-scale, state-supported, and multinational funding mechanisms. Such financial backing plays a critical role in enabling interdisciplinary projects and long-term policy-oriented research.

Figure 14. Leading funding sponsors in resilience research



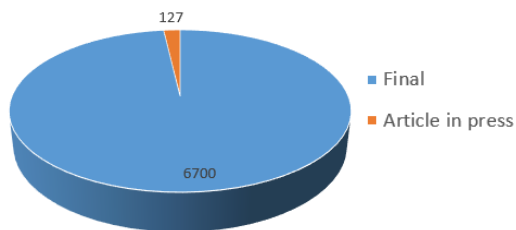
Funding Sponsor	Count
Undefined	3493
Nat. Nat. Sci. Found. of China	378
Min. of Sci. & Tech., China	326
European Commission	293
National Science Foundation (U.S.)	269
UK Research and Innovation (UKRI)	179
Horizon 2020	127
Nat. Key R&D Program of China	111
Government of Canada	83
Chinese Acad. of Sciences	76

As shown in Figure 15, the vast majority of publications on “climate change resilience” have been finalized, with 6,700 documents published in their final form. This indicates that a significant part of the literature has completed the scientific process, passed peer review, and is publicly accessible in full text.

There are 127 documents listed as “articles in press,” meaning they have been accepted but not yet released in final version. This reflects the ongoing relevance of the field and the steady intensity of academic output.

This distribution confirms that most research has reached its final state and that the analysis is based on reliable, accessible sources. It also highlights the ongoing evolution of the literature supported by pre-print and early access systems.

Figure 15. Publication stages of climate change resilience studies



Publication Stage	Count
Final	6700
Article in Press	127

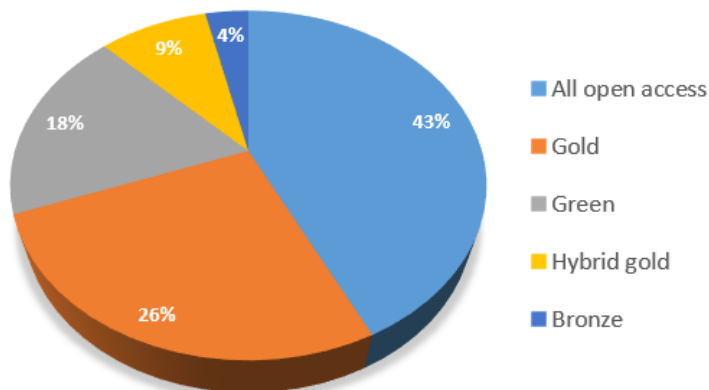
As shown in Figure 16, a total of 3,326 publications on “climate change resilience” have been released as open access. This figure demonstrates that a significant portion of the literature is publicly accessible. Open access is particularly important for global topics such as sustainability and climate policy, as it facilitates the wider and faster dissemination of academic knowledge.

The most common type of open access is Gold Open Access, which accounts for 2,056 publications. This model involves the author paying a publication fee to make the article freely available to all readers. It is followed by Green Open Access (1,420 publications), in which authors freely share their articles through institutional repositories or personal platforms.

The Hybrid Gold model (691 publications) allows selected articles within subscription-based journals to be published as open access. Bronze Open Access (275 publications) refers to content that is free to read but lacks a clear license, meaning that access may be temporary and reuse is restricted.

These data indicate that a substantial proportion of research output is published under open access models, which is a highly positive trend in terms of both knowledge equity and scientific visibility.

Figure 16. Distribution of open access types in climate change resilience research



Open Access Type	Count
All Open Access	3326
Gold	2056
Green	1420
Hybrid Gold	691
Bronze	275

Table 1 presents data on the five most highly cited publications under the title of “climate change resilience,” according to Scopus. This analysis highlights the most influential and field-shaping academic works.

At the top of the list is a review article which provides an in-depth theoretical exploration of the concept of urban resilience (Meerow, Newell, & Stults, 2016). With a total of 1,884 citations, it is the most frequently referenced work in the literature. The second most cited publication is a report by the Lancet Commission published by Whitmee et al. (2015), which focuses on sustainable

health systems and has received 1,873 citations. This work underscores the relevance of resilience not only in environmental contexts but also in relation to public health.

Other highly cited studies—such as those by Backer et al. (2018), Vicente-Serrano et al. (2013), and Davoudi et al. (2012)—examine resilience within the frameworks of agriculture, drought impacts, and planning theory, thereby supporting the concept’s applied, interdisciplinary, and multi-scalar character.

These findings demonstrate that the topic of climate change resilience draws from highly influential scholarly works and contributes not only to theoretical development but also to practical applications across various domains.

Table 1. Most cited publications on climate change resilience (Scopus)

Rank	Title (Abbreviated)	Author(s)	Year	Citations
1	Defining urban resilience: A review	Meerow, S. et al.	2016	1884
2	Safeguarding human health in the Anthropocene: Rockefeller–Lancet Comm.	Whitmee, S. et al.	2015	1873
3	Plant growth-promoting rhizobacteria and sustainable agriculture	Backer, R. et al.	2018	1303
4	Response of vegetation to drought time-scales across global land biomes	Vicente-Serrano, S.M. et al.	2013	1266
5	Resilience: A bridging concept or a dead end?	Davoudi, S. et al.	2012	1241

CONCLUSION AND EVALUATION

This study aimed to examine the academic literature on climate change resilience using bibliometric methods and presented a comprehensive analysis based on the Scopus database. The findings reveal a significant increase in scientific interest in this field, particularly after 2015. The identification of a total of 6,827 academic publications demonstrates that the topic has rapidly evolved into a globally prominent research area.

The research results clearly indicate that climate change resilience is a highly multidisciplinary subject. While the majority of publications are concentrated in environmental sciences, substantial academic contributions are also evident in social sciences, agriculture, engineering, urban studies, and economics. This highlights that the concept of resilience is addressed not only within an ecological framework but also through its social, economic, and governance dimensions.

An analysis of publication types shows that the literature is predominantly shaped by peer-reviewed journal articles. Similarly, the high number of open access publications suggests that knowledge produced in this area plays an important role in knowledge dissemination and in increasing scientific impact.

Country-based productivity data show that the United States, China, and the United Kingdom continue to lead in publication output, while countries such as South Africa, India, and Brazil also make notable contributions to the literature. Likewise, the most productive institutions and authors are based in different geographic regions, indicating that research on climate change resilience is grounded in global collaboration.

Keyword analysis reveals that the terms *climate change* and *resilience* are frequently used together, with other commonly occurring terms including *adaptation*, *sustainability*, *vulnerability*, and *drought*. The most highly cited publications are those with both conceptual depth and practical impact, addressing a wide range of themes from urban planning and agriculture to disaster management and environmental policy.

The funding data reveal that actors such as China, the European Union, and the United States significantly support academic production in this field. The fact that the vast majority of publications have been released in their final version confirms both the reliability of the dataset and the maturity of the literature.

Additionally, an analysis of the journals most frequently publishing on this topic shows that Sustainability (Switzerland) hosts the highest number of publications by a wide margin. It is followed by prominent journals such as the Handbook of Climate Change Resilience, Science of the Total Environment, and the International Journal of Disaster Risk Reduction. This distribution highlights the strong connection of the topic not only to environmental sciences but also to applied fields such as disaster management, urban planning, and development studies. Furthermore, the diversity of publication platforms indicates that research output is enriched not only with theoretical contributions but also with practice-oriented content.

Another noteworthy finding of the study is the diversity among the most productive authors and institutions. Authors such as Sharifi, A., Luginaah, I., and Moustakas, M. are identified as leading contributors who have shaped the literature through interdisciplinary work. Similarly, institutions like the Chinese Academy of Sciences, the University of Melbourne, and Wageningen University & Research demonstrate high publication output, indicating that the field is supported not only by theoretical discourse but also by field-oriented scientific production. This structure suggests that research is shaped within a global network while remaining linked to local contexts.

Finally, citation analysis shows that the most highly cited works in the field of climate change resilience are those that develop conceptual frameworks and offer policy-relevant, practice-oriented recommendations. Studies focusing on the concept of “urban resilience” receive substantial citation attention, reflecting the increasing importance of the topic at the urban scale. Additionally, empirical studies on specific themes such as drought, agricultural resilience, and ecosystem-based adaptation are also among the most

cited, highlighting the conceptual richness and broad application scope of the resilience concept.

In conclusion, the bibliometric analysis conducted in this study systematically reveals the structural characteristics, thematic trends, and research gaps within the literature on climate change resilience. The findings not only summarize the current academic landscape but also provide a valuable roadmap for future interdisciplinary collaborations, strategic research planning, and policy development processes.

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