Table 1. Various definitions of urban geology in sequence years. Each definition is accompanied by selected preferred key concepts, which are later a combination of these key concepts become keywords to filter literature in the Scopus database.

|  |  |  |  |
| --- | --- | --- | --- |
| Year | Definitions |  | Preferred key concepts |
| 1970 | “Urban geology in the modern context is considered to be a close synonym for environmental geology” [18] |  | urban geology; environmental geology |
| 1988 | “Urban geology is the application of geological knowledge of urban areas to the solution of engineering geological problems” [5] |  | urban geology; engineering geology; urban areas |
| 1992 | “Urban geology considered as the field of applied geology that deals with major population centers and covers parts of engineering geology, environmental geology, and land management, where geotechnics (rock-/soil mechanics) and geohydrology disciplines are of major importance in urban geology” [2] |  | urban geology; engineering geology; environmental geology; land management |
| 1994 | “Urban geology is the study of land resources and geologic hazards related to the development, redevelopment, and expansion of urban areas. It focuses not only on the study of the physical environment on which the city is located but also on the prediction of its changes under the influence of human engineering and economic activities, provided for those responsible for urban planning and decision making from the viewpoint of engineering geology” [30] |  | urban geology; development; expansion; urban areas; city; urban planning; engineering geology |
| 2005 | “Whether it is called urban geology or environmental geology, there has always been a need for the study of how geology affects cities development” [19] |  | urban geology; environmental geology; city; cities; development |
| 2006 | “Urban geology means integrating surface and sub-surface geoscientific information for development needs” [29] |  | urban geology; development |
| 2007 | “Urban geology is the application of geologic knowledge to the planning and management of metropolitan areas” [28] |  | urban geology; planning; management; metropolitan area |
| 2011 | “Urban geology is the study of the interaction of human and natural processes with the geological environment in urbanized areas and the resulting impacts, and the provision of the necessary geo-information to enable sustainable development, regeneration and conservation” [1] |  | urban geology; geological environment; urban areas; |
| 2011 | “Urban geology provides information required for sound urban planning and sustainable development in densely populated areas” [4] |  | urban geology; urban planning; development |
| 2015 | “Urban geology focuses on monitoring using remote sensing; data, mapping, and modeling; and geohazards in the urban environment” [41] |  | urban geology; geohazards; urban environment |
| 2016 | “Urban geology is the application of the earth sciences to problems arising at the nexus of the geosphere, hydrosphere, and biosphere within urban and urbanizing areas, where it goes beyond the application of geology in civil engineering (commonly called engineering geology) and draws on the entire toolbox of the earth sciences, from stratigraphy to geochemistry and hydrogeology to geophysical exploration techniques, linking to the biological and environmental sciences” [10] |  | urban geology; urban areas; engineering geology; environmental science |

Table 2. Stage processes for inclusion and exclusion criteria for search terms

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Stage | Inclusion/ exclusion | Description | Search terms | | Results |
| First | Inclusion based on search terms | Keywords | (TITLE-ABS-KEY (“urban geology”)) OR (TITLE-ABS-KEY (environmental AND geology\*)) OR (TITLE-ABS-KEY (engineering AND geology\*)) AND (TITLE-ABS-KEY (geolog\* AND urban OR city OR cities OR metro\* OR megacit\* AND planning OR development)) | 1478 | |
| Second | Exclusion on document type | Only journal articles are included | AND (LIMIT-TO (DOCTYPE, “ar”)) | 735 | |
|  | Exclusion on language | Only journal articles written in English are included. Those are written in other languages are excluded. | AND (LIMIT-TO (LANGUAGE, “English”)) AND (EXCLUDE (LANGUAGE, “French”) OR EXCLUDE (LANGUAGE, “German”) OR EXCLUDE (LANGUAGE, “Italian”) OR EXCLUDE (LANGUAGE, “Persian”) OR EXCLUDE (LANGUAGE, “Spanish”) OR EXCLUDE (LANGUAGE, “Croatian”) OR EXCLUDE (LANGUAGE, “Finnish”)) | 595 | |
|  | Exclusion on the subject area | Those that are too broad on the subject area are excluded | AND (EXCLUDE (SUBJAREA, “MEDI”) OR EXCLUDE (SUBJAREA, “BUSI”) OR EXCLUDE (SUBJAREA, “PHAR”) OR EXCLUDE (SUBJAREA, “CENG”) OR EXCLUDE (SUBJAREA, “CHEM”) OR EXCLUDE (SUBJAREA, “MATE”) OR EXCLUDE (SUBJAREA, “BIOC”) OR EXCLUDE (SUBJAREA, “PHYS”) OR EXCLUDE (SUBJAREA, “ECON”) OR EXCLUDE (SUBJAREA, “ARTS”) OR EXCLUDE (SUBJAREA, “DECI”) OR EXCLUDE (SUBJAREA, “IMMU”) OR EXCLUDE (SUBJAREA, “MATH”) OR EXCLUDE (SUBJAREA, “MULT”) OR EXCLUDE (SUBJAREA, “NURS”) OR EXCLUDE (SUBJAREA, “PSYC”) OR EXCLUDE (SUBJAREA, “ENER”) OR EXCLUDE (SUBJAREA, “COMP”)) | 529 | |
| Third | Exclusion based on citation information, abstract, and keywords. | Those that are too broad on the subject area are excluded | Transfer to PDF.  Topics that are too broad-based on title, abstract, author keywords, and index keywords manual review | 285 | |

Table 3. Summary of the three mapped clusters

|  |  |  |
| --- | --- | --- |
| Cluster | Number of terms | Terms |
| 1 | 14 | China; engineering geology; Eurasia; geology; geomorphology; geotechnical engineer; groundwater; hazard assessment; hazards; hydrogeology; mapping; planning; soils; subsidence |
| 2 | 14 | Environmental geology; Geographic Information System; geological mapping; G.I.S.; land use; land use planning; risk assessment; sustainable development; United States; urban area; urban development; urban geology; urban growth; urban planning |
| 3 | 14 | Article; environmental impact; floods; hydrology; rain; runoff; storm sewers; storms; stormwater; urbanization; water management; water pollution; water quality; water supply |

Table 4. Detail description of terms with the most significant link strength accordingly

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Terms | Total link strength | Weight | Cluster |  | Terms | Total link strength | Weight | Cluster |
| Engineering geology | 81.00 | 88 | 1 |  | Geotechnical Eng. | 20.00 | 21 | 1 |
| Geology | 77.00 | 84 | 1 |  | Urban geology | 20.00 | 20 | 2 |
| Urban planning | 55.00 | 63 | 2 |  | Risk assessment | 18.00 | 18 | 2 |
| Urban area | 53.00 | 53 | 2 |  | Soils | 18.00 | 19 | 1 |
| Land use | 36.00 | 37 | 2 |  | Geological mapping | 18.00 | 19 | 2 |
| Urban development | 35.00 | 36 | 2 |  | Water supply | 18.00 | 18 | 3 |
| GIS | 32.00 | 34 | 2 |  | Urban growth | 18.00 | 18 | 1 |
| Groundwater | 26.00 | 27 | 1 |  | Water management | 18.00 | 18 | 3 |
| Eurasia | 26.00 | 26 | 1 |  | Hazards | 18.00 | 18 | 1 |
| Storm sewers | 24.00 | 24 | 3 |  | Hydrogeology | 17.00 | 17 | 1 |
| Urbanization | 24.00 | 24 | 3 |  | China | 17.00 | 18 | 1 |
| Storms | 23.00 | 23 | 3 |  | Subsidence | 16.00 | 16 | 1 |
| Article | 22.00 | 22 | 3 |  | Mapping | 15.00 | 15 | 1 |
| Geog. Information Syst. | 22.00 | 22 | 2 |  | Rain | 15.00 | 15 | 3 |
| Environmental impact | 22.00 | 22 | 3 |  | Floods | 15.00 | 15 | 3 |
| Runoff | 21.00 | 21 | 3 |  | Water pollution | 15.00 | 15 | 3 |
| Environmental geology | 21.00 | 23 | 2 |  | Water quality | 14.00 | 15 | 3 |
| Geomorphology | 20.00 | 20 | 1 |  | Sustainable dev. | 14.00 | 15 | 2 |
| Stormwater | 20.00 | 20 | 3 |  | Hydrology | 14.00 | 15 | 3 |
| Hazard assessment | 20.00 | 20 | 1 |  | Planning | 14.00 | 15 | 1 |
| United States | 20.00 | 20 | 2 |  | Land use planning | 13.00 | 15 | 2 |