From Crisis to Adaptation: Harnessing Emerging Technologies for Government Response to (Environmental) Challenges

A Systematic Literature Review Process

Matilde Biagioni
Dottoranda in Legalità, Culture Politiche e Democrazia
Università degli Studi di Perugia

Convegno dei Giovani e delle Giovani STAI - AIS Ambiente e Territorio
Bari, 30-31 maggio 2024
Crisi permanenti: la dimensione territoriale delle sfide socio-ambientali

SOCIO-ECONOMIC

GEOPOLITICAL

POLYCRISES / MULTIPLE CRISES

"complex intersolidarity of problems, antagonisms, crises, uncontrollable processes, and the general crisis of the planet" (Morin & Kern, 1999, p. 74).
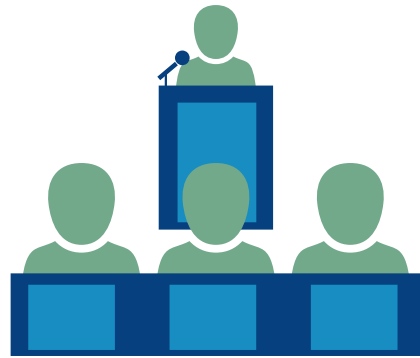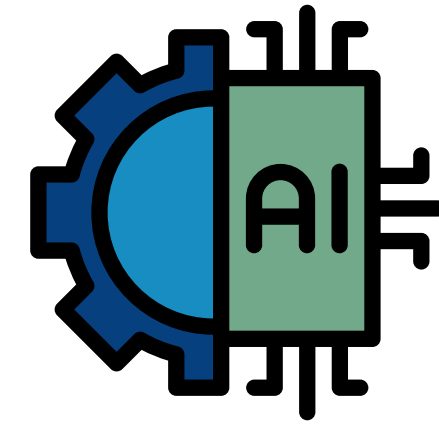
MIGRATION

PANDEMIC

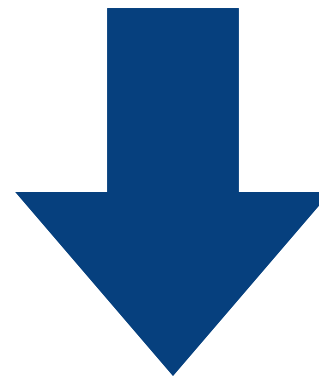ENVIRONMENTAL

AGAINST THIS BACKDROP

RENEWED ROLE OF PUBLIC SECTOR

EMERGING TECHNOLOGIES

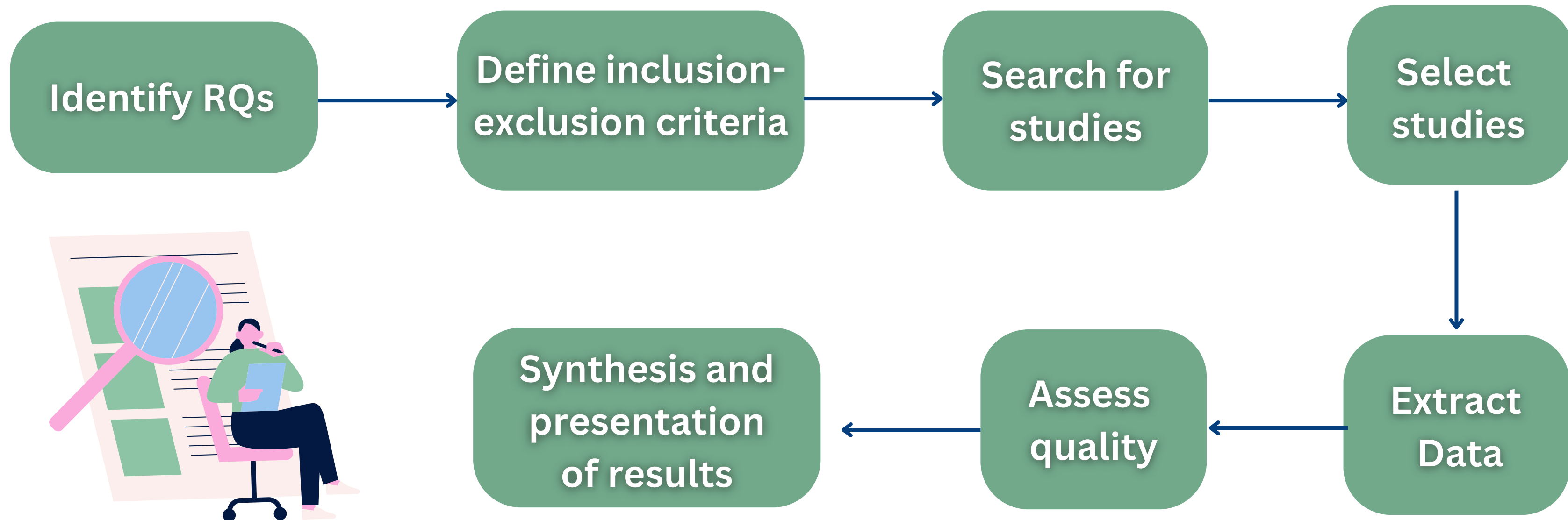- **What types of emerging technologies (ETs) are used in the public sector?**

- **In what types of crises are ETs used by the public sector?**

A SYSTEMATIC LITERATURE REVIEW

- **WHAT IS IT?**
- **WHY?**

Identify RQs → Define inclusion-exclusion criteria → Search for studies → Select studies → Extract Data → Assess quality → Synthesis and presentation of results

DIGITAL LIBRARIES SOURCES

Definition of inclusion-exclusion criteria

CRITERIA	INCLUSION	EXCLUSION
Period	2008-2024	Prior 2008
Language	English	All other languages
Type of source	Article of Journals	Conference, papers, book and chapters

WORD SELECTION: EMERGING TECHNOLOGIES
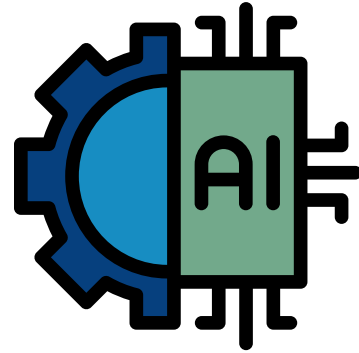
Comparison of the 3 lists of ETs
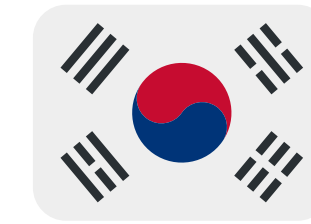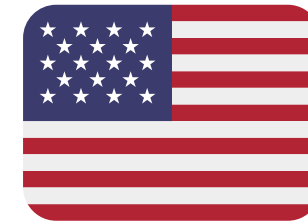
Selected the fields (and relative technologies) specified in at least 2 out of 3 cases

Comparison of results with the ETs identified by Sinan Küfeoglu

Final result: 45 ETs

WORD SELECTION: CRISIS MANAGEMENT
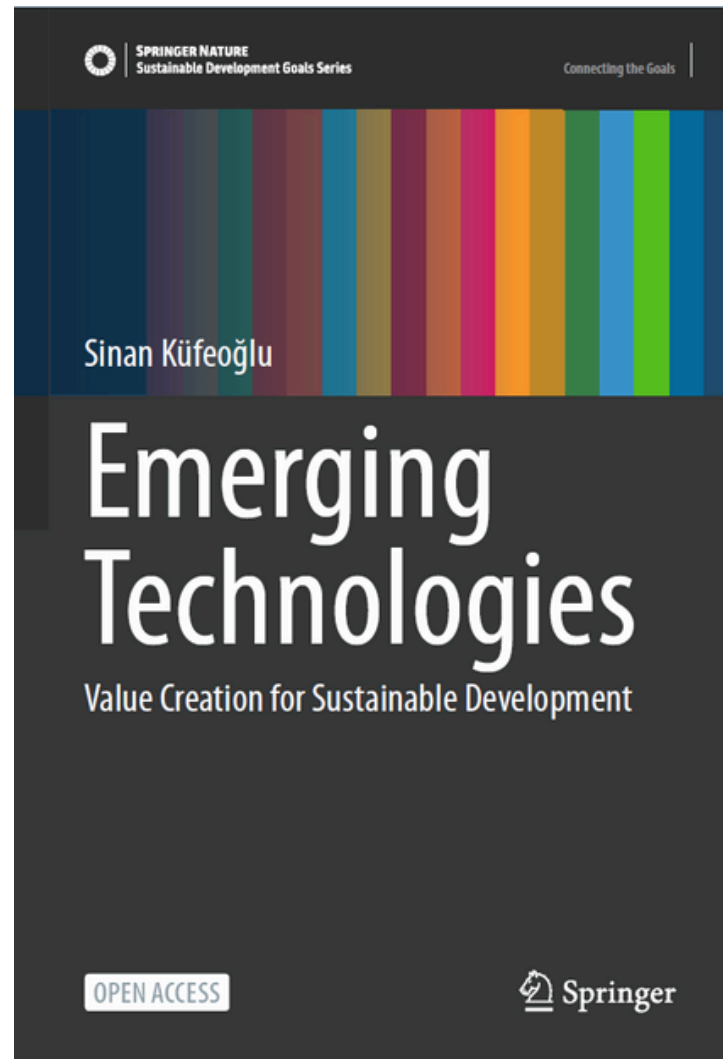
WORD SELECTION: PUBLIC SECTOR AND TERRITORY

Universiteit Leiden
The Netherlands

Organizational and institutional crisis management
Kuipers S; Wolbers J

Crises and Crisis Management:
Toward Comprehensive Government
Decision Making

Uriel Rosenthal
Leiden University, The Netherlands
Alexander Kouzmin
University of Western Sydney

Universiteit Leiden
The Netherlands

Crisis management in government
Kuipers, S.L.; Schedler, K.
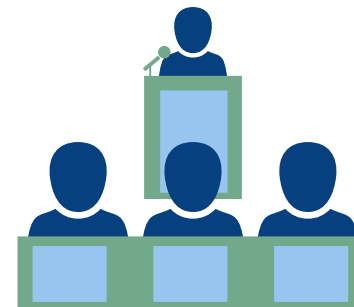
territor* OR municipal* OR local* OR country OR countries OR county OR counties OR provinc* OR region* OR state OR nation* OR feder* OR district*

SEARCH FOR STUDIES...

(**TI=(**"emerg* tech*" OR "3D print*" OR 5g OR "advanced material*" OR "advanced ceramic*" OR "bioengineer* material*" OR "nanocomposite material*" OR semiconductor* OR metamaterial* OR "nanocarbon material*" OR "machine learning" OR "deep learning" OR "artificial intelligence" OR AI OR "neural network*" OR "reinforce* learning" OR "autonomous vehicle*" OR "big data" OR biometric* OR bioplastic* OR biomanufactur* OR biotech* OR "synthetic biology" OR bioinformatic* OR "gene therap*" OR "regenerative medicine" OR "mRNA vaccine*" OR blockchain* OR "carbon capture and storage" OR CCS OR "lithium-ion batter*" OR "cloud computing" OR cybersecurity OR "data hubs" OR "digital twins" OR drone* OR "edge computing" OR "energy storage" OR "flexible electronic*" OR "healthcare analytics" OR hydrogen OR "internet of things" OR IoT OR "natural language process" OR "quantum computing" OR robotic*OR "spatial computing" OR "augmented realit*" OR "virtual realit*")) AND **TI=(**Crisis OR Crises OR Management OR Risk* OR Response* OR Resilien* OR Preparedness OR Threat* OR Disaster* OR Recover* OR Emergency OR emergencies OR Prevent* OR Vulnerab* OR Hazard* OR Monitor* OR Mitigat* OR Detect* OR predict*)) AND **TI=(**"public management" OR "public sector*" OR "public organization*" OR "public administration" OR leader* OR polic* OR govern* OR politic* OR "decision mak*" OR institution* OR authorit* OR agenc*)) **OR AK=(**"emerg* tech*" OR ...)) AND **AK=(**Crisis OR Crises OR...)) AND **AK=(**"public management" OR...)) **AND AB=(**"emerg* tech*" OR...)) AND **AB= (**Crisis OR Crises OR...)) AND **AB=(**"public management" OR "public sector*" OR "public organization*" OR "public administration" OR leader* OR polic* OR govern* OR politic* OR "decision mak*" OR institution* OR authorit* OR agenc*)) AND **AB=(**territor* OR municipal* OR local* OR country OR countries OR county OR counties OR provinc* OR region* OR state OR nation* OR feder* OR district*)) AND **LA=(**English)) AND **PY=(**2008-2024)

"Search all papers that have ETs associated with Crisis Management and Public Sector BOTH in the abstract AND in Author Keywords or Title AND that are associated ONLY in the abstract with territoriality terms" (only English texts in the last 15 years).

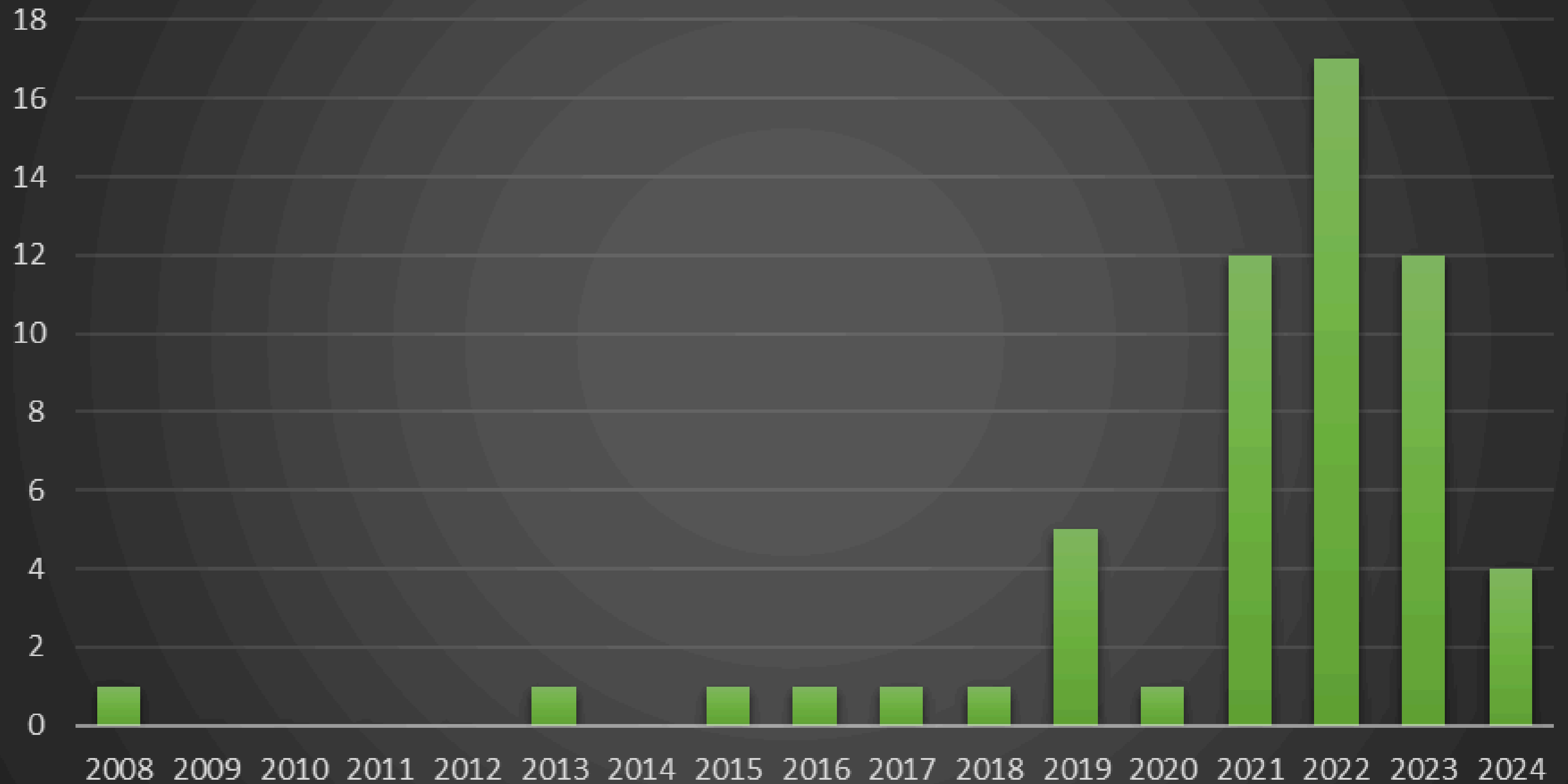# A STRING FOCUSED ON NATURAL RESOURCES AND ENVIRONMENTAL CRISES

(**TI**=("emerg* tech*" OR "3D print*" OR 5g OR "advanced material*" OR "advanced ceramic*" OR "bioengineer* material*" OR "nanocomposite material*" OR semiconductor* OR metamaterial* OR "nanocarbon material*" OR "machine learning" OR "deep learning" OR "artificial intelligence" OR AI OR "neural network*" OR "reinforce* learning" OR "autonomous vehicle*" OR "big data" OR biometric* OR bioplastic* OR biomanufactur* OR biotech* OR "synthetic biology" OR bioinformatic* OR "gene therap*" OR "regenerative medicine" OR "mRNA vaccine*" OR blockchain* OR "carbon capture and storage" OR CCS OR "lithium-ion batter*" OR "cloud computing" OR cybersecurity OR "data hubs" OR "digital twins" OR drone* OR "edge computing" OR "energy storage" OR "flexible electronic*" OR "healthcare analytics" OR hydrogen OR "internet of things" OR IoT OR "natural language process" OR "quantum computing" OR robotic* OR "spatial computing" OR "augmented realit*" OR "virtual realit*")) **AND TI**=(Crisis OR Crises OR Management OR Risk* OR Response* OR Resilien* OR Preparedness OR Threat* OR Disaster* OR Recover* OR Emergency OR emergencies OR Prevent* OR Vulnerab* OR Hazard* OR Monitor* OR Mitigat* OR Detect* OR predict*)) **AND TI**=("public management" OR "public sector*" OR "public organization*" OR "public administration" OR leader* OR polic* OR govern* OR politic* OR "decision mak*" OR institution* OR authorit* OR agenc*)) **OR AK**=("emerg* tech*" OR...)) AND **AK**=(Crisis OR...)) AND **AK**=("public management" OR...)) AND AB=("emerg* tech*" OR...)) **AND AB**=(Crisis OR...)) AND AB=("public management" OR...)) **AND AB**=(territor* OR municipal* OR local* OR country OR countries OR county OR counties OR provinc* OR region* OR state OR nation* OR feder* OR district*)) **AND AB**=("natural resource*" OR soil* OR land* OR agricultur* OR water OR air OR forest*) **AND LA**=(English)) **AND PY**=(2008-2024)

N = 57 (WoS 52 and DGRL 5)

WOS CATEGORIES: ENVIRONMENTAL STRING

13 Environmental Sciences	5 Environmental Studies	4 Green Sustainable Science Technology	3 Health Care Sciences Services	3 Medical Informatics

- 13 Environmental Sciences
- 8 Computer Science Information Systems
- 5 Environmental Studies
- 5 Meteorology Atmospheric Sciences
- 4 Geosciences Multidisciplinary
- 4 Green Sustainable Science Technology
- 3 Health Care Sciences Services
- 3 Medical Informatics
- 3 Remote Sensing
- 3 Telecommunications
- 2 Agriculture Multidisciplinary
- 2 Agronomy
- 2 Business
- 2 Computer Science Artificial Intelligence
- 2 Computer Science Hardware Architecture

SOME EXAMPLES OF THE RESULTS: ENVIRONMENTAL STRING

Automated environmental compliance **monitoring** of rivers with **IoT** and open **government** data

By   Miasayedava, L (Miasayedava, Lizaveta) [1] ; McBride, K (McBride, Keegan) [2] ; Tuhtan, JA (Tuhtan, Jeffrey Andrew) [3]

View Web of Science ResearcherID and ORCID   (provided by Clarivate)

Abstract   Environmental **monitoring** of rivers is a cornerstone of the European Union's **Water** Framework Directive. It requires the estimation and reporting of environmental flows in rivers whose characteristics vary widely across the EU member states. This variability has resulted in a fragmentation of estimation and reporting methods for environmental flows and is exhibited by the myriad of regulatory guidelines and estimation procedures. To standardise and systematically evaluate environmental flows at the pan-European scale, we propose to formalise the estimation procedures through automation by reusing existing river **monitoring** resources. In this work, we explore how sensor-generated hydrological open **government** data can be repurposed to automate the estimation and **monitoring** of river environmental flows. In contrast to existing environmental flows estimation methods, we propose a scalable **IoT**-based architecture and implement its cloud-layer web service. The major contribution of this work is the demonstration of an automated environmental flows system based on open river **monitoring** data routinely collected by **national authorities**. Moreover, the proposed system adds value to existing environmental **monitoring** data, reduces development and operational costs, facilitates streamlining of environmental compliance and allows for any **authority** with similar data to reuse or scale it with new data and methods. We critically discuss the opportunities and challenges associated with open **government** data, including its quality. Finally, we demonstrate the proposed system using the Estonian **national** river **monitoring** network and define further research directions.

Comparative analysis of **machine learning** and multi-criteria **decision making** techniques for landslide susceptibility mapping of Muzaffarabad district

By   Khalil, U (Khalil, Umer) [1] ; Imtiaz, I (Imtiaz, Iqra) [2] ; Aslam, B (Aslam, Bilal) [3] ; Ullah, I (Ullah, Israr) [4] ; Tariq, A (Tariq, Aqil) [5] , [6] ; Qin, SJ (Qin, Shujing) [7]

View Web of Science ResearcherID and ORCID   (provided by Clarivate)

Abstract   **Landslides** are natural **disasters** deliberated as the most destructive among the others considered. Using the Muzaffarabad as a case study, this work compares the performance of three conventional **Machine Learning** (ML) techniques, namely Logistic Regression (LGR), Linear Regression (LR), Support Vector Machine (SVM), and two Multi-Criteria **Decision Making** (MCDM) techniques, namely Analytical Hierarchy Process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) for the susceptibility mapping of **landslides**. Most of these techniques have been used in the **region** of Northern Pakistan before for the same purpose. However, this study for **landslide** susceptibility assessment compares the performance of various techniques and provides additional insights into the factors used by adopting multicollinearity analysis. **Landslide**-inducing factors considered in this research are lithology, slope, flow direction, fault lines, aspect, elevation, curvature, earthquakes, plan curvature, precipitation, profile curvature, Normalized Difference **Water** Index (NDWI), Normalized Difference Vegetation Index (NDVI), roads, and waterways. Results show that SVM performs better than LGR and LR among ML models. On the other hand, the performance of AHP was better than TOPSIS. All the models rank slope, precipitation, elevation, lithology, NDWI, and flow direction as the top three most imperative **landslide**-inducing factors. Results show 80% accuracy in **Landslide** Susceptibility Maps (LSMs) from ML techniques. The accuracy of the produced map from the AHP model is 80%, but for TOPSIS, it is less (78%). In **disaster** planning, the produced LSMs can significantly help the **decision-makers**, town planners, and **local management** take necessary measures to decrease the loss of life and assets.
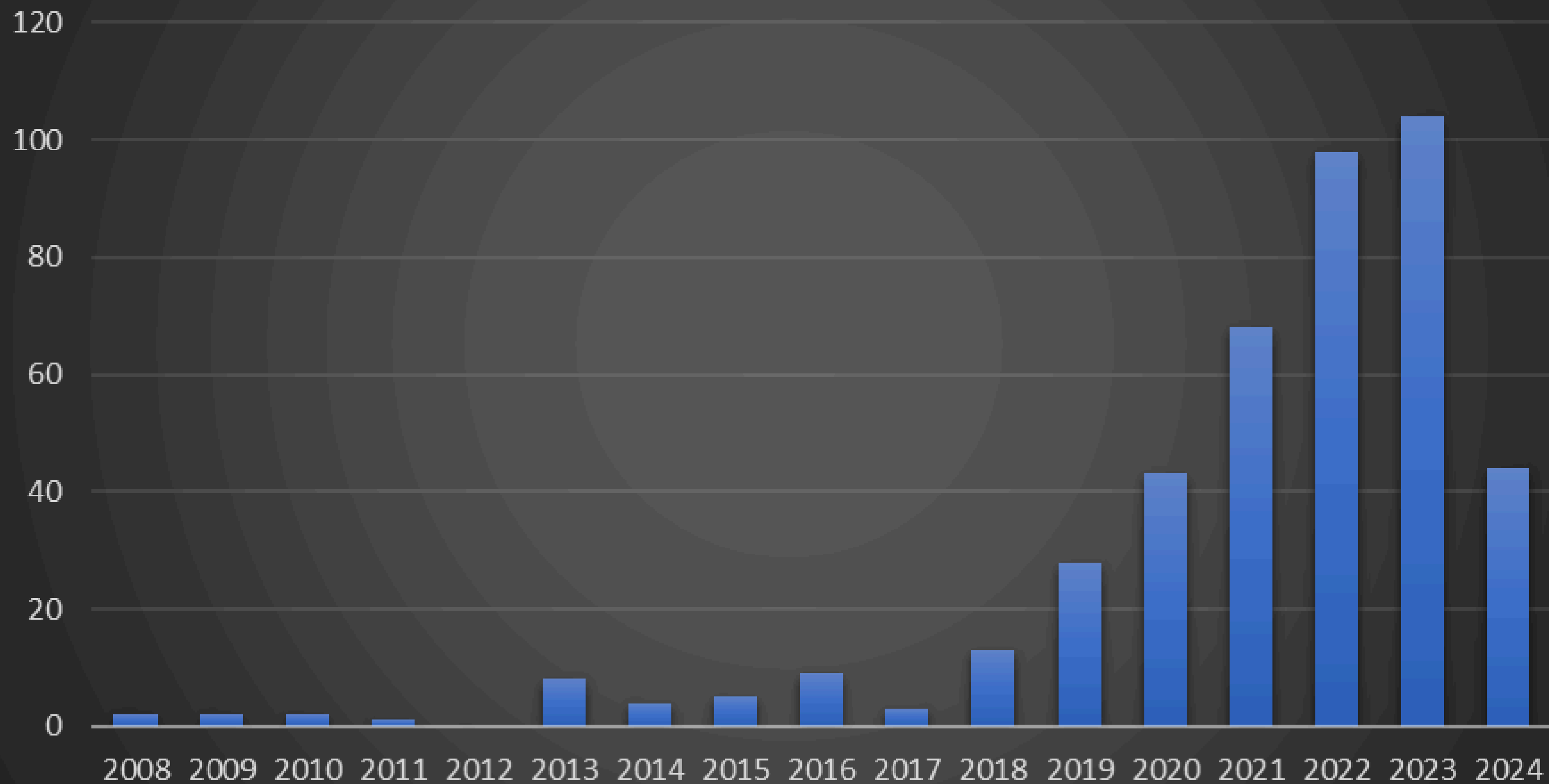
WOS CATEGORIES: GENERAL STRING

82 Engineering Electrical Electronic Technology

73 Computer Science Information Systems

41 Telecommunications

36 Computer Science Artificial Intelligence

32 Environmental Sciences

25 Computer Science Interdisciplinary Applications

23 Environmental Studies

22 Automation Control Systems

21 Green Sustainable Science Technology

21 Management

19 Computer Science Theory Methods

18 Business

20 Energy Fuels

19 Information Science Library Science

18 Engineering Civil

Publication Years of Articles (WoS and DGRL)

SOME EXAMPLES OF THE RESULTS: GENERAL STRING

Governance, technology and citizen behavior in pandemic: Lessons from COVID-19 in East Asia

By
Shaw, R (Shaw, Rajib) [1] ; Kim, YK (Kim, Yong-kyun) ; Hua, JL (Hua, Jinling)

View Web of Science ResearcherID and ORCID   (provided by Clarivate)

Document Type   Article

Abstract
Corona Virus (CODID-19) was first reported in Wuhan in December 2019, then spread in different parts of China, and gradually became a global pandemic in March 2020. While the death toll is still increasing, the epicenter of casualty has shifted from Asia to Europe, and that of the affected people has shifted to USA. This paper analyzes the responses in East Asian countries, in China, Japan and South Korea, and provides some commonalities and lessons. While countries have different governance mechanism, it was found that a few governance decisions in respective countries made a difference, along with strong community solidarity and community behavior. Extensive use of emerging technologies is made along with medical/health care treatment to make the response more effective and reduce the risk of the spread of the disease. Although the pandemic was a global one, its responses were local, depending on the local governance, socio-economic and cultural context. (C) 2020 The Authors. Published by Elsevier Ltd.

Keywords
Author Keywords: COVID-19 pandemic; Governance response; Emerging technology; Citizen behavior; East Asia

The political economy of carbon capture and storage: An analysis of two demonstration projects

By
Kern, F (Kern, Florian) [1] ; Gaede, J (Gaede, James) [2] ; Meadowcroft, J (Meadowcroft, James) [2] ; Watson, J (Watson, Jim) [1]

View Web of Science ResearcherID and ORCID   (provided by Clarivate)

Abstract
Carbon Capture and Storage (CCS) technology is considered key to mitigating climate change by international institutions and governments around the world. The technology is considered advantageous because it may enable the continued utilization of fossil fuels while curbing carbon emissions. However, development of the technology remains slow on the ground. It is generally argued that large-scale, integrated demonstration projects are needed as a next step toward commercialization. Despite government support in several countries, few projects exist so far worldwide. This paper asks why it is so difficult to get demonstration projects off the ground. The argument is that it is not only project-specific factors that determine the feasibility of demonstration, but given the need for government support, a variety of political economy factors influence decision-making processes by policy makers and companies. The paper introduces an analytical framework developed on the basis of the political economy literature that considers six sets of factors that influence outcomes. It discusses two specific projects, Longannet in the UK and Quest in Canada, and explains why one failed and the other one is under construction. The analysis shows that although climate change has been a more important policy concern in the UK compared to Canada, the specific political economy situation of fossil fuel rich provinces like Alberta has led the Quest project going forward. (C) 2015 Elsevier Inc. All rights reserved.

Keywords
Author Keywords: Carbon capture and storage; Technology demonstration projects; Political economy; UK; Canada; climate change mitigation
Keywords Plus: CO2 CAPTURE; TECHNOLOGICAL TRANSITIONS; CCS; POLICY; UK; LESSONS

NOW...

a work in progress

Qualitative assessment on abstract

- Identification of ETs (Yes/No)
- Critical situation described (Yes/No)
- Presence of Public Sector/Public Actors (Yes/No)
- Territorial level indicated: municipal; provincial; regional, county; state, federal, national, other (specify)

AFTER THAT...

Qualitative assessment of the papers

- The remaining eligible abstracts ⟶ **codebook**

- Labels to categorise elements within the dataset (papers)

- The papers are analysed to identify

1) which ETs are used by the public sector; 2) in what types of crises; 3) the geographic region taken into consideration; 4) the territorial level of public management; 5) the relation with the policy area, 6) the methodology used, etc.

MAIN REFERENCES

- Carrera-Rivera A., Ochoa W., Larrinaga F., Lasa G., "How-to conduct a systematic literature review: A quick guide for computer science research", in MethodsX, Vol. 9, 2022, pp. 1-12.
- CEU. RTD_1., Strategic Crisis Management in the EU: Improving EU Crisis Prevention, Preparedness, Response and Resilience. (LU: Publications Office, 2022), https://data.europa.eu/doi/10.2777/517560.
- Christensen, T., Lægreid, P., & Rykkja, L. H., "Organizing for Crisis Management: Building Governance Capacity and Legitimacy", in Public Administration Review, 76(6), 2016, pp. 887–897.
- Corrocher N., Malerba F., & Montobbio F., "The Emergence of New Technologies in the ICT Field: Main Actors", in Working Papers of Faculty of Economics, University of Insubria, 2003.
- Fatima, S., Desouza, K. C., & Dawson, G. S., "National strategic artificial intelligence plans: A multi-dimensional analysis", in Economic Analysis and Policy, 67, 2020, pp. 178–194.
- Hamirul, Darmawanto, Nova Elsyra, Syahwami, "The Role of Artificial Intelligence in Government Services: A Systematic Literature Review", Open Access Indonesia Journal of Social Sciences, Vol 6, Issue 3, 2023, pp. 998-1003.
- Hart, P., "Public Leadership in Times of Crisis: Mission Impossible? Crisis: A Window for Leadership? Consciousness: Leadership Challenges", in Public Administration Review, 63(5), 2001, pp. 544–553.
- Kuipers S; Wolbers J., Crisis Management in Government. (2022). In: Schedler K. (Ed.) Elgar encyclopedia of public management. Cheltenham, UK: Elgar. 217-221.
- Kuipers S; Wolbers J., Organizational and institutional crisis management. (2021). Organizational and institutional crisis management. In Oxford Research Encyclopedia of Politics. doi:10.1093/acrefore/9780190228637.013.1611
- Lawrence M, Homer-Dixon T, Janzwood S, Rockstöm J, Renn O, Donges JF (2024). Global polycrisis: the causal mechanisms of crisis entanglement. Global Sustainability 7, e6, 1–16. https://doi.org/ 10.1017/sus.2024.1
- Montoya, L., & Rivas, P., "Government AI readiness meta-analysis for Latin America and The Caribbean", in In Paper presented at the 2019 IEEE international symposium on technology and society (ISTAS), 2019, Boston, USA.
- OECD, Global Trends in Government Innovation 2023, OECD Public Governance Reviews, 2023, OECD Publishing, Paris, https://doi.org/10.1787/0655b570-en.
- Onder M.& Uzun M., "Roles of Artificial Intelligence (AI) on COVID-19 Pandemic Crisis Management Policies", in International Journal of Public Administration in the Digital Age, Vol. 8, Issue 2, 2021, pp. 1-13.
- Rosenthal U., Kouzmin A., Crises and Crisis Management: Toward Comprehensive Government Decision Making, in Journal of Public Administration Research and Theory, p. 277-297, 1997.
- Rotolo Daniele, Hicks Diana, Martin Ben R., "What is an emerging technology?", in Research Policy, Vol. 44, Issue 10, 2015, pp. 1827-1843.
- Shalu, Gurjeet Singh, "Environmental Monitoring with Machine Learning", in EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal, Vol. 9, Issue 5, May 2023, pp. 208-212.
- Ubaldi, B., et al., "State of the art in the use of emerging technologies in the public sector", in OECD Working Papers on Public Governance, N. 31, OECD Publishing, Paris, 2019.

THANK YOU FOR YOUR ATTENTION!

Matilde Biagioni
Dottoranda in Legalità, Culture Politiche e Democrazia
Università degli Studi di Perugia

Convegno dei Giovani e delle Giovani STAI - AIS Ambiente e Territorio
Bari, 30-31 maggio 2024
Crisi permanenti: la dimensione territoriale delle sfide socio-ambientali