Geospatial Asset Intelligence (GeoAI) – A New Challenge for National and Global Technology Assessment

Detlef Briesen (Giessen/Hanoi)[i]

This essay examines whether new technologies such as GeoAI are already subject to systematic technology assessment (TA). Geospatial Asset Intelligence (GeoAI) involves the collection of spatial data, its analysis and the development of practical applications based on this data by governments, authorities and companies. GeoAI derives its particular potential from the combination of geodata with techniques from the field of artificial intelligence.

The essay proceeds in several steps: it first briefly highlights the relevance of societal space and then describes the novel technical processes of GeoAI. In further steps, the situation in technology assessment at national and global levels is examined. AI technologies will have a significant impact on geopolitical relations at all scales. The search for a TA for artificial intelligence then leads to a negative result and thus also for GeoAI. However, this rather sobering assessment should not deter us from initiating such a process. The essay therefore ends with a call for further research rather than presenting solutions to what is certainly a significant potential for humankind, but also an emerging area of concern.

I. The relevance of societal space

Space is an important societal category, but its relevance outside of geography has only been increasingly recognised since the 1990s. Sociology in particular, long considered the supreme discipline among the social sciences, had even been explicitly proud of its anti-spatial orientation. The starting point for the new (old) insights was that certain social changes can only be explained if spatial categories are taken into account. This paradigm shift was also referred to as a topological turn. Other terms used are spatial, topographical or topological turn.

Since the 1980s, Doreen Massey (2005), David Harvey (2001) and Edward Soja (1989) have been particularly meritorious in bringing about this paradigm shift. An important precursor to a socio-theoretical spatial theory was Henri Lefebvre (1974) in the previous decade. Inspired by Karl Marx, he developed a theory of the social production of space, which he explained as the interaction of three factors: spatial practice, the representation of space, and spaces of representation. Lefebvre understood the latter to be complex symbolisations and spaces of imagination. Marxist theorists such as Henri Lefebvre assume a structural, i.e. capitalist-global determinism of spaces. They thus predict a growing homogenisation of space on a global scale. This contrasts with action-theoretical and postcolonial conceptions, which emphasise the heterogeneity of local contexts and the locality of all our actions and knowledge in and about the world.

What we can glean from these few statements possible in this context is at least this: space is not only significant, but also a central category for human life on planet Earth. The crucial point here is that societal space is a holistic category in the sense of each of the concepts briefly mentioned above, whether based on Marxism, action theory or postcolonialism. This is precisely why all attempts to empirically record and analyse societal space on any scale (from local to global) and to control it on the basis of such evaluations, i.e. to implement policies, are of enormous consequence. Such spatial policies, whether at the level of governments or large corporations, have a profound impact on the respective forms of socialisation of human beings. Spatial policies are not sectoral, but rather holistic in nature, reflecting the overall character of space; they are not merely concerned with steering individual aspects of social life. Even classic policies for the organisation and design of spaces, such as urban and spatial planning or the planning of colonial territories, thus aim at far-reaching socio-political goals: the coordination and design of space uses for various social, political and economic goals, or the prevention of undesirable behaviour and development. However, such classic policies have been limited by insufficient technical capabilities: most attempts at design have failed due to the complexity of their tasks. This has changed in recent years with the emergence of AI-supported geospatial processes that can generate and analyse spatial data on a previously unimaginable scale, increasingly enabling their operators to make profound interventions in societal contexts in real time.

The new technologies of GeoAI (Geospatial Asset Intelligence) thus create novel opportunities for geopolitics on a wide range of scales and have so far been insufficiently debated, let alone examined in terms of their implications (see Hård/ Lösch/Verdicchio 2002). They are the subject of this essay, which cannot propose solutions, but whose task is first and foremost to identify a new research problem.

The first section of this essay therefore presents the fascinating and threatening novel potential of GeoAI, from which the need for a global technology assessment can be deduced. The second section then examines the current characteristics and shortcomings of this global technology assessment (TA). The third section deals with another new research question, namely the extent to which technology assessment in the field of artificial intelligence has existed to date. The conclusion of the essay is that, given the current state of research, it is not possible to make recommendations for a global assessment of GeoAI. The aim of this essay is therefore rather to draw attention to a novel problem that the social sciences interested in technology assessment will certainly deal with more intensively in the future.

II. Artificial intelligence and geospatial data analysis (GeoAI)

GeoAI is a prime example of the influence AI could have on the analysis and control of social conditions in the future. It is created by combining AI with geographic information systems (GIS), offering unprecedented new possibilities for mapping, 3D modelling and spatial data interpretation. This revolution will pave the way for innovations in the application of spatial information in a wide variety of areas, including urban and spatial planning, environmental monitoring, disaster management and crisis intervention. What is important here is the enormous potential of AI-supported data analysis, which goes far beyond mere data collection and encompasses complex analyses and predictive models, enabling improved decision-making capabilities for operators and customers of AI systems, as well as optimised use of technology. An increase in public safety is also expected, as is a perceived increase in state and social control. Geospatial artificial intelligence is therefore not only revolutionising traditional scientific and commercial geodata analysis, but also fundamentally changing and expanding the way in which certain users can generate and use geodata for various purposes (the following description according to GeoAI. https://pro.arcgis.com/de/pro-app/3.3/help/analysis/ai/geoai.htm; GeoAI. Artificial Intelligence for Geospatial Data. https://opengeoai.org/.; GeoAI. https://www.esri.com/de-de/capabilities/geoai/overview; Geospatial Artificial Intelligence: Harnessing AI and Spatial Data for Innovation. https://geoai.au/;Earth Intelligence. Strategic Impact Through Earth Observation. https://www.geoaitech.com/)

The central component of GeoAI is the transformative integration of geographic information systems (GIS) with advanced artificial intelligence (AI) technologies, especially machine and deep learning. Such integration not only accelerates the existing methods of knowledge acquisition, but it also generates entirely new insights and can contribute to innovative solutions to complex spatial problems of all kinds by providing deeper insights than were previously possible. GeoAI's data sources include a wide range of information about the spaces on planet Earth, provided that this information is available in digital or digitised form or can be collected: for example, satellite images, coordinates from the human or natural environment, terrain data and much more. Such data is obtained by GeoAI as part of a systematic process: data collection is based on satellites, drones, GPS devices and all spatially locatable signals. The AI systems used prepare such data in a first step, among other things to find errors and standardise data formats. In a second step, pre-processed data is combined with other data, such as information relating to economic activities, social structures and population statistics. The aim of this step is to increase the informative value of the spatial analyses.

GeoAI significantly accelerates the speed at which relevant information can be generated from complex data sets. Thus, it is a holistic concept that operates in a comprehensive ‘spatial’ sense, i.e. it can process all available information about all human, biogeographical or geological conditions in their most diverse interconnections and make it available for a wide variety of analysis and application purposes. In principle, GeoAI enables all organisations with the appropriate resources to record and analyse conditions and processes on planet Earth and make them usable for their respective purposes. Advertisement by companies that operate GeoAI systems emphasise the following core advantages in particular:

- Precision in data collection and analysis: By using techniques such as machine and deep learning, GeoAI can generate and analyse complex data sets with much greater accuracy than was previously possible, minimising errors, especially those caused by humans. This is crucial for precision applications, such as the monitoring and control of agricultural production, urban and spatial planning, and resource management.
- Automation of data processing: GeoAI can process large amounts of data in an automated manner in a short period of time. The time and effort required to analyse geodata is significantly reduced. Such automation is particularly suitable for continuous monitoring and real-time data analysis. All forms of environmental change, in both rural and urban contexts, can thus be continuously monitored.
- Predictive analytics: This feature of GeoAI enables all its users to anticipate future scenarios and take appropriate precautions. GeoAI can generate trends or models for upcoming developments through complex data analysis. Such predictions can be highly valuable in terms of disaster management, resource allocation, and urban and rural development. These predictive analytics can also perform timely risk assessments and suggest solutions before potential threats become actual dangers.

However, even a brief overview of its current areas of application shows that GeoAI is an ambivalent achievement with the potential to profoundly impact human societies.

- Healthcare and epidemiology: GeoAI is suitable for more precise monitoring of diseases, especially epidemics, and the associated intervention options, enabling health authorities and pharmaceutical companies to analyse extensive data sets to detect epidemics and predict their further spread. This has already been successfully applied in monitoring of dengue fever epidemics or via AI-supported tools such as FINDER, which use online search data and geolocation to identify restaurants with a higher risk of foodborne illness. GeoAI mapping technologies have played a crucial role in monitoring and containing the COVID-19 epidemic, as this technology can be used to geolocate outbreak hotspots and spread patterns.
- Disaster management: This area highlights the potential benefits of GeoAI for the entire process of crisis and disaster management, from prevention to reconstruction. By combining GIS with remote sensing, risk assessments can be carried out to identify particularly vulnerable areas and organise emergency measures more quickly. In the event of natural disasters, satellite images and environmental data can be systematically analysed, and the same applies to damage assessment and possible reconstruction planning. Aerial photographs

combined with geodata analysis make it possible to determine every impact on the natural and built environment – from environmental protection to warfare.

- Public safety: A similarly ambivalent picture emerges when it comes to the profound impact that GeoAI can have on public safety, especially regarding improvements in law enforcement capabilities and public safety, not only at the community level. Predictive policing tools based on AI algorithms are now available that can be deployed to forecast potential crime scenes and times. Public spaces can not only be better monitored using video systems, for example, but GeoAI also makes it possible to recognise unusual or criminally suspicious behaviour and intervene accordingly. GeoAI also improves traffic management by predicting accidents based on analysis of weather conditions and road data.

However, these technical developments, as fascinating and shocking as they may be, are only just beginning. Further innovations in GeoAI are anticipated from the integration of virtual reality (VR) into geographic information systems (GIS), which could revolutionise urban planning and management as well as environmental monitoring. Significant increases in machine computing power are also expected through the continuous development of even more powerful quantum computers and through so-called edge computing, i.e. decentralised data processing with minimised transmission times, to achieve real-time monitoring systems.

Companies working in GeoAI particularly emphasise its transformative potential for emerging economies. Artificial intelligence-based geoinformation systems can indeed fill the information gaps that governments in developing countries often face due to poor governance. In principle, this makes it possible to create better decision-making opportunities in or for countries in the Global South – in critical areas such as public order, infrastructure development, agriculture, environmental protection, disaster relief, education and healthcare. On the other hand, AI-supported geodata analysis has so far originated from the traditional global innovation hubs of East Asia, North America and Western Europe, where it has been designed for various applications and is also operated. So far, there is no guarantee that the benefits of GeoAI will not be limited to wealthy nations and their technology centres and companies. This requires not only measures to promote inclusive digital cooperation and reduce inequalities on a global scale. With the spread of GeoAi, these technologies must be critically reviewed on a global scale. As a result, the question arises as to how GeoAI technologies are assessed in a global context, who decides on their use, and what opportunities for societal control exist in all countries and in the Global South in particular.

III. Technology assessment in the Global North

Such problem areas are the subject of what is known as technology assessment (TA), which has been in existence in many industrialised countries for several decades. TA claims to be a problem-oriented, transdisciplinary and empirical research discipline that investigates the effects of scientific and technological innovations on economy and society. Its aim is to systematically identify risks associated with technologies and to recognise any resulting problems in good time to minimise, mitigate or even completely prevent negative effects. TA is extremely diverse in its organisational forms; it is mainly carried out in the countries of the Global North and the parliaments, governments, authorities, university and non-university research institutions, associations and interest groups that exist there. The various TA institutions have different assessment concepts (for example German Technikfolgenabschätzung is different from US technology assessment), each with their own objectives, theoretical foundations and research methods, as well as a very different degree of proximity or distance to economic and other interests (the following description according to Saretzki 2014; Renn 2014).

TA originated in the United States in the 1960s. At that time, many politicians, especially in the US Congress, were increasingly coming to the conclusion that, on the one hand, they were too often required to make parliamentary decisions on far-reaching technological policy budgetary issues. On the other hand, they increasingly found themselves unable to competently assess the consequences of scientific and technological progress and its presumed far-reaching effects on the economy, society and culture. Parliamentarians recognised how much they were exposed to information from the government and experts who often argued on their own behalf during the relevant hearings.

This unease gave rise to TA, which aimed to review new technologies as independently and systematically as possible. Since then, TA has had the function of identifying the implications and effects of applied research and technology, evaluating them, publishing the results and contributing to relevant political debates and decisions. The first authority of this kind was the Office of Technology Assessment (OTA), established by the US Congress in 1972. This development gave rise to the principles of technology assessment, which have remained essentially valid to this day:

- The most comprehensive possible recording of all relevant consequences of a technological application (comprehensiveness).
- The provision of relevant knowledge as early as possible, especially for the political elite (early warning).
- The orientation of TA towards decision-making (goal orientation).
- Mandatory review of the consequences of alternative decisions and also review of their possible consequences (examination of alternatives).
- Involvement of interest groups and the public (participation).

Since its implementation, OTA has been subject to sharp criticism from companies, trade associations and technology-oriented research (technology harassment) and was dissolved again in 1995, which however did not stop the spread of TA, at least in the Global North. Nevertheless, TA itself is by no means characterised by supranational standards and procedures. The reasons for this lie not only in the different legal bases and political structures in the respective countries, but also in a fundamental problem: the consequences of scientific and technological innovations cannot be explained solely by their respective technical characteristics. Technological innovations are implemented in rather diverse national contexts in which economy, environment, politics and culture often vary considerably. Thus, knowledge of how a technology works alone does not allow predictions to be made about its effects in a national or societal context. TA therefore requires the integration of natural and engineering science with social science research. There is a considerable deficit in this area in all countries that have institutionalised TA.

A second problem is the question of which ethical principles should underlie TA and on which criteria its decisions should be based. This ethical problem cannot be solved simply by the leading empirical natural scientists and engineers involved in TA adhering to their gold standard: universal procedures, such as the textbook sequence of theory, choice of method, experiment and research result. TA also aims to address the societal impact of technologies in the broadest sense. As a result, TA cannot be value-neutral; rather, it requires ethical or at least socio-political foundations.

In Western Europe, attempts are being made to mitigate this problem by referring to consensually interpretable, normative societal concepts. In the Federal Republic of Germany, for example, where the debate began shortly after that in the USA and which is now one of the leading countries in TA, the terms 'environmental compatibility' (Umweltverträglichkeit) and 'social compatibility' (Sozialverträglichkeit) were mainly used until the early 1990s. Since then, the term 'sustainable development' has established itself as the most important normative basis. Sustainability was brought to the attention of a wider public in 1992 at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro. Even before, German 'technology assessment', has primarily followed the paradigm of sustainability, in recent years focusing on the consequences of climate change. Even sustainability and climate change have remained controversial socio-political terms, as it can never be ruled out that those involved in TA are not merely articulating personal views or seeking to assert their own interests or those of their commissioning parties.

Important conclusions can be drawn from the German experience, which are based on the practical application of technology assessment. In the Federal Republic of Germany, systematic TA began in 1990 with the establishment of the 'Office of Technology Assessment at the German Parliament (TAB)', thus on the initiative of the federal parliament like in the US. Since 1995, the actual TA for the Bundestag and its committees has been carried out by the Institute for Technology Assessment and Systems Analysis (ITAS/KIT) in Karlsruhe. However, the establishment of ITAS/KIT was also an indicator of the increase in societal debate about the opportunities and risks of science and technology beyond the discourse between parliament and scientific experts. Remarkable developments have taken place over the last three decades:

- On the one hand, the German legislature's demand for advice on technological innovations and their effects has continued to grow.
- On the other hand, TA has become relevant to society-wide debates on scientific and technological progress (participatory TA). Furthermore, TA has now become part of the technological and scientific processes themselves (integrated TA). TA can promote interdisciplinarity and foster the creative potential of innovations (see TAB beim Deutschen Bundestag. https://www.tab-beim-bundestag.de/).

To summarise: it is a key achievement that TA is being implemented at all, given that the findings of science and research are to be applied in practice. Furthermore, the timing of when TA is to be launched in the course of such processes is crucial. In addition, it seems to be very important not only to anchor TA in parliamentary decision-making processes, but also to integrate it into societal debates and, above all, into innovation processes themselves.

IV. Towards global TA?

So far, we have looked at the systematic assessment of technology impacts at national level, with reference to the United States and the Federal Republic of Germany. Looking again at the potential of GeoAI for all nations as described above, two crucial problem areas have not yet been considered:

- Firstly, developments in science and technology and the resulting innovation processes have a wide range of global impacts. They are influenced by the respective state of society, culture, political systems, socio-economic development and, last but not least, by the respective standard of science and technology.
- Secondly, innovation processes are not evenly distributed across all countries on a global level. To date, technical and scientific innovations, including GeoAI, have originated in North America, Western Europe and East Asia, where China now occupies a dominant position ahead of Japan and South Korea. The concurrent TA processes, according to the somewhat disconcerting findings, are also taking place in precisely these countries.

In view of this dilemma of TA, which reviews technologies for the respective nation state, but which can be used anywhere in the world, there are increasing efforts to evaluate technological innovation processes more systematically in terms of their global impact. The fundamental problem here is that scientific and technological research operates worldwide according to fairly uniform standards, whereas the contexts into which innovations are imported are extremely diverse. According to optimistic voices, global TA must be made possible because it is, in principle, necessary for all countries of the world. The realistic aim is not to achieve a globally standardised technology assessment in the future. Previous discussions on the topic have rather tended to see the central task as developing flexible TA parameters that can be applied in the respective national contexts.

The concept was first developed by Scherz/Hahn/Ladikas (2019) on the basis of empirical data on TA in countries as diverse as Australia, China, India and Russia. As early as 2015, Hennen/Nierling (2015) introduced the notion of 'TA habitat', which could serve as a starting point for the global spread of TA, but in various forms in the respective countries. According to these ideas, each national TA is also a step towards its global dissemination. The parameters mentioned are political decision-making structures, public accountability, problem-oriented research activities, public awareness of STI issues and the socially articulated determination to take technological consequences into account when shaping policy.

Existing studies generally cite the same parameters for the globalisation of TA, with Scherz/Hahn/Ladikas (2019) proposing four of them:

- function of political systems,
- relativisation of the Western normative foundations,
- a global governance system for science and technology, and
- recognition of the diversity of development needs.

Hennen et al. (2023) refer to these parameters as

- political systems,
- science and technology governance systems,
- socio-economic stages of development, and
- national values.

In summary, it appears that our search for a global TA for worldwide high-profile technologies such as GeoAI has so far been largely unsuccessful.

V. In search of a TA for artificial intelligence

There is hardly any other field in which the problems outlined above are as concentrated as in artificial intelligence, of which GeoAI is also a key product. AI is not only considered a core technology of the future in the analysis of geodata. The most important economies are investing considerable resources in research and development in this area. In addition to GeoAI, other promising applications that are often mentioned include machine learning, language processing, intelligent transport systems, robotic surgery, expert systems and, last but not least, the numerous AI-supported programmes that are currently spreading rapidly on PCs, notebooks and mobile phones. Further examples include deep learning, AI-controlled online platforms and applications in the economic and financial sectors, etc.

What is crucial for the context of this essay, however, is that there has been no technology assessment for AI at either the national or, especially, the global level. In this respect, it is only recognisable in its infancy, if at all, in relation to GeoAI. What does exist, on the other hand, is a repetition of the process by which technologies are developed within a national framework and also subjected to a corresponding national technology assessment. Nevertheless, the technologies are being applied globally. Lei Huang and Walter Peissl (2023) deserve special credit for demonstrating that AI development and the debate surrounding it are confined to global innovation centres. This can be illustrated by looking at the usual centres of global technology development, such as the USA, Western Europe, China, Japan and South Korea.

- The United States has created a comprehensive policy framework for the development of AI. At least the US government (and, accordingly, its economy and perhaps also large sections of society) is aiming for global leadership in AI, with applications particularly in areas relevant to power, i.e. the economy, culture, security and the military.
- The EU is focusing its AI measures on modernising applications for research and development for the economy, industrial manufacturing, healthcare and the energy sector. An important goal of the EU is cooperation between Member States in the field of AI, for which national plans are being harmonised and research funds made available.

China has a comprehensive socio-political framework for AI development. There is a national planning basis, industry guidelines, support programmes and education plans. These incorporate the following components for proactive AI promotion: research and development, industrialisation, talent promotion, education and training, standardisation and regulation, ethical standards and security. In addition, under the heading 'Governance Principles for New Generation AI', attempts are being made to develop responsible AI. According to China's view, this is based on the following eight principles: harmony, friendliness, fairness, inclusiveness, respect for privacy, security and controllability, shared responsibility, open cooperation and agile governance.

Japan and South Korea have also taken an active political stance on AI development. According to the Japanese strategy published in 2019, the development of AI should be geared towards addressing social challenges, such as the problems of an ageing society. South Korea's artificial intelligence strategy, published in December 2019, places AI in the context of global digital competitiveness on the one hand and emphasises its importance for improving living standards in the country itself on the other.

In South America and Africa, on the other hand, not all countries have their own AI strategy yet. Where such strategies do exist, they are still primarily focused on digital transformation and data governance.

In summary, AI policies are highly multifaceted, even when comparing the major economies. They range from global power politics to the promotion of the national economy and the handling of humanitarian issues. Overall, they reflect the respective national political, economic, social and technological level of development and the associated political articulation of national interests.

To put it another way: in the field of AI (and for sure in GeoAI), even national technology assessment is still in its infancy, with no signs of more global efforts. The relevant publications on the subject therefore focus on those lists of parameters that can be derived from the general desiderata for national or global technology assessment. These include:

- A code of conduct or application for everyone who develops, implements and uses AI. These actors need a global ethical foundation, i.e. guidance based on principles such as human dignity, accountability, the rule of law, security, data protection and privacy, sustainability, etc.
- The transparency of AI systems. Only through transparency are accountability and control possible. The demand for transparency stands in stark contrast to the complexity of AI, which makes it almost impossible for many to understand and comprehend its internal decision-making processes. Making AI systems more transparent is therefore a highly complex interdisciplinary task of enormous importance.

AI, and GeoAI technologies in particular, have the potential to trigger enormous societal transitions. However, these transformations do not necessarily lead to a more equitable distribution of resources, neither internally within individual societies nor globally between countries and regions around the world. On the contrary, the already uneven distribution of resources could further increase inequalities, for example in the form of digital gaps on a global scale. In order to ensure the responsible use of AI, for example in the field of GeoAI, a whole range of the shortcomings outlined above need to be addressed, in the field of TA, its globalisation, in dealing with AI in general and GeoAI in particular.

VI. Approaches to technology assessment for GeoAI?

After these observations, it should be clear that there is currently no global technology assessment for a productive but sometimes questionable technology such as GeoAI in its many forms.

So far, there are only approaches for a more global TA and, even more so, for a more widespread technology assessment in the field of artificial intelligence worldwide. This may be a frustrating conclusion, given both the potential and the risks of GeoAI outlined above. After all, it is based on the fundamental idea of intervening deeply in all areas of human life. This is because spatial-societal interventions have an unique dimension – they are not sectoral, but holistic. However, initial approaches to implementing a TA for GeoAI have also been identified. If this essay can make at least a small contribution towards this goal, even if only by identifying a significant socio-political problem area, then, in the author's view, it has already fulfilled its purpose.

References

Earth Intelligence. Strategic Impact Through Earth Observation. https://www.geoaitech.com/.

GeoAI. Artificial Intelligence for Geospatial Data. https://opengeoai.org/.

GeoAI. https://pro.arcgis.com/de/pro-app/3.3/help/analysis/ai/geoai.htm.

GeoAI. https://www.esri.com/de-de/capabilities/geoai/overview.

Geospatial Artificial Intelligence: Harnessing AI and Spatial Data for Innovation. https://geoai.au/.

Hård, Mikael/Lösch, Andreas/Verdicchio, Dirk (eds.) (2002): Transforming Spaces. The Topological Turn in Technology Studies. Online Publication of the international Conference held in Darmstadt, Germany, March 22–24, 2002.

Harvey, David (2001): Spaces of Capital: Towards a Critical Geography. Edinburgh.

Hennen, Leonhard (eds.) (2023): Technology Assessment in a Globalized World. Facing the Challenges of Transnational Technology Governance. Cham.

Hennen, Leonhard (et al.) (2023): Introduction: Technology Assessment Beyond National Boundaries. In: Hennen, Leonhard (eds.) (2023): Technology Assessment in a Globalized World. Facing the Challenges of Transnational Technology Governance. Cham. P. 1-14.

Hennen, Leonhard/Nierling, Linda (2015): Taking Stock of TA in Europe and Abroad. Introduction to the Thematic Focus. Schwerpunkt Technikfolgenabschätzung – Theorie und Praxis 24. Jg., Heft 1, Februar 2015. pp.4-10.

Lefebvre, Henri (1974): La production de l'espace. Paris.

Lei Huang/Peissl, Walter (2023): Artificial Intelligence—A New Knowledge and Decision-Making Paradigm? In: Hennen, Leonhard (eds.) (2023): Technology Assessment in a Globalized World. Facing the Challenges of Transnational Technology Governance. Cham. pp. 175-201.

Massey, Doreen (2005): For Space. London.

Renn, Ortwin (2014): Mit Sicherheit ins Ungewisse. Möglichkeiten und Grenzen der Technikfolgenabschätzung – Essay. In: APuZ. Aus Politik und Zeitgschcihte vom 27.1.2014.

Saretzki, Thomas (2014): Entstehung und Status der Technikfolgenabschätzung. In: APuZ. Aus Politik und Zeitgschichte vom 27.1.2014.

Scherz, Constanze/Hahn, Julia/Ladikas (2019): Technology Assessment in a Globalized World. In: Sciendongineering. Management Systems. Volume 27, Issue 3, pp. 149-152.

Soja, Edward (1989): Postmodern Geographies: The Reassertion of Space in Critical Social Theory. London.

TAB beim Deutschen Bundestag. https://www.tab-beim-bundestag.de/.

---

[i] PD Dr. Dr. Detlef Briesen is affiliated with the Fachbereich 4, History and Cultural Studies, Justus-Liebig-Universität Gießen, Germany. He can be contacted at Detlef.Briesen@geschichte.uni-giessen.de , dr.detlef.briesen@gmail.com