TATuP

ZEITSCHRIFT FÜR TECHNIKFOLGENABSCHÄTZUNG IN THEORIE UND PRAXIS

JOURNAL FOR TECHNOLOGY ASSESSMENT IN THEORY AND PRACTICE

www.tatup.de peer reviewed & open access 31/3 (2022)

The future of radioactive waste disposal

Special topic The future of radioactive waste disposal: What are the developments and challenges after site selection?

Research Human dignity and lethal autonomous weapon systems

Interview with T. Vietor: Swiss repositories for nuclear waste

TATuP – Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis ist die begutachtete Open-Access-Zeitschrift für das interdisziplinäre Feld der Technikfolgenabschätzung und angrenzende Forschungsgebiete. Die Zeitschrift richtet sich an eine inter- und transdisziplinäre Leserschaft.

TATuP – Journal for Technology Assessment in Theory and Practice is the peer reviewed open access journal for the interdisciplinary field of technology assessment and neighboring fields of research. It addresses an inter- and transdisciplinary readership.

IMPRESSUM / LEGAL NOTICE

HERAUSGEBER/EDITOR

Karlsruher Institut für Technologie (KIT)
Institut für Technikfolgenabschätzung
und Systemanalyse (ITAS)
Karlstraße 11
76133 Karlsruhe, Germany

VERLAG / PUBLISHING HOUSE

oekom – Gesellschaft für ökologische
Kommunikation mit beschränkter Haftung
Waltherstraße 29
80337 München, Germany

Institut für Technikfolgenabschätzung
und Systemanalyse (ITAS)
Karlstraße 11
76133 Karlsruhe, Germany
+49 (0)721 608 26014
redaktion@tatup.de

HINWEISE FÜR AUTORINNEN UND AUTOREN / INFORMATION FOR AUTHORS

www.tatup.de/index.php/tatup/Submit

ERSCHEINUNGSWEISE / PUBLICATION SCHEDULE

3× jährlich / 3× per year

BESTELLUNG / SUBSCRIPTION

www.tatup.de/index.php/tatup/subscriptionStatic

www.oekom.de/tatup/bezug
Verlegerdienst München GmbH
Aboservice oekom verlag
Gutenbergstraße 1
82205 Gilching, Germany
+49 (0)8105 388 563
+49 (0)8105 388 333
oekom-abo@verlegerdienst.de

TATuP ONLINE

www.tatup.de
Newsletter: www.oekom.de/newsletter

PAPIER / PAPER

Gedruckt auf Circle Volume White, 100 % FSC®-Recycling-papier, zertifiziert mit dem Blauen Engel (RAL-UZ 14). / Printed on Circle Volume White, 100 % FSC® recycled paper, certified with The Blue Angel (RAL-UZ 14).

DRUCK / PRINTING

Friedrich Pustet GmbH & Co. KG
93051 Regensburg, Germany
www.pustet-druck.de

ANZEIGEN / ADVERTISEMENTS

Karline Folkendt
oekom – Gesellschaft für ökologische
Kommunikation mit beschränkter Haftung
+49 (0)89 544184-217
anzeigen@oekom.de

VISUELLE KONZEPTION & GESTALTUNG / VISUAL CONCEPT & DESIGN

Kornelia Rumberg, www.rumbergdesign.de

GRAFIK & SATZ / GRAPHIC DESIGN & TYPESET

Tobias Wantzen, www.wantzen.com
Cover art based on © starline / Freepik

ISSN

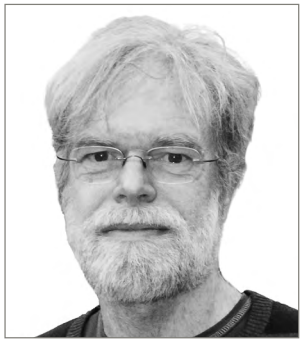
2568-020X (Print), 2567-8833 (Online)

Erfüllungsort / Gerichtsstand: München, Deutschland
Place of fulfillment / Place of jurisdiction: Munich, Germany

RECYCLED
Papier aus Recyclingmaterial
FSC® C014889
www.fsc.org

oekom kompensiert bereits seit 2008 seine unvermeidlichen CO_2-Emissionen. / Since 2008 oekom offsets its unavoidable CO_2 emissions.

Editorial



SVEN OVE HANSSON
Department of Philosophy and History, Royal Institute of Technology, Stockholm, SE (soh@kth.se)

Spent nuclear fuel stays radiotoxic for hundreds of thousands of years. It is generally agreed that for permanent storage, it has to be placed in containers with minimal leakage risk, deposited in deep geological formations. However, that has not yet happened. Instead, about 400.000 tons of high-level nuclear waste, accumulated from about 70 years of both civil and military nuclear activities, are kept in different types of interim storage facilities. In order to solve this problem, we need to answer quite a few difficult questions:

Should the waste be reprocessed for reuse in reactors? Through reprocessing, more energy can be extracted from the fuel, and the amount that needs to be permanently stored will decrease significantly. However, reprocessing is expensive, and in order to obtain full effect from it, breeder reactors are needed.

Should the waste repository be permanently sealed, or should it be possible for future generations to retrieve the waste? Sealing the repository prevents retrieval for belligerent purposes, but also for beneficial purposes that we may not be able to foresee.

Should we try to inform future generations of the dangerous site, and in that case how? It is no easy task to make signposts that remain intact hundreds of thousands of years into the future and can be understood by those who live then.

Should we deposit the waste now, or later when we know more? The knowledge argument for delay can always be made, since there will be no end to new scientific information. But at some point we will have to decide that we know enough. Is that point now?

Is the deposition of nuclear waste a strictly national or also an international responsibility? There are good reasons why each country should take care of its own waste. But on the other hand, today's nations may not be very relevant in a time perspective reaching hundreds of thousands of years into the future.

Should local populations have a veto against the siting of a waste repository? There are strong reasons for local influence, but can we let local influence lead to extended delays or to siting in suboptimal geological formations?

All of these are questions that technology assessment has methods and tools to analyze. Hopefully, an increased involvement of technology assessors can contribute to breaking some of the deadlocks that stand in the way of a safe permanent storage of the nuclear waste.

Sven Ove Hansson

https://doi.org/10.14512/tatup.31.3.3

Inhalt/ Content 31/3 (2022)

SPECIAL TOPIC

The future of radioactive waste disposal

The question of permanent storage of highly radioactive waste, or nuclear waste, is still unsolved in a number of countries all over the world. This is due to unanswered technical questions as well as to social and political issues. This TATuP Special topic addresses this sociotechnical problem from both a practical and a scientific point of view.

10

EDITORIAL

3 S. O. HANSSON

TA FOCUS

6 *Meldungen • TA-Grafik • Aus dem openTA-Kalender • 5 Fragen an Kai Gehring • Personalia*

SPECIAL TOPIC
THE FUTURE OF RADIOACTIVE WASTE DISPOSAL: WHAT ARE THE DEVELOPMENTS AND CHALLENGES AFTER SITE SELECTION?

11 U. SMEDDINCK, A. ECKHARDT, S. KUPPLER
Toward a repository for high-level radioactive waste: Perspectives and approaches

18 M. BERG, T. HASSEL
Challenges in communicating the future of high-level radioactive waste disposal: What future are we talking about?

24 S. FRENAY, C. PAROTTE
No time to waste: Exploring timeprints of radioactive waste management options in Belgium

31 M. KOJO, M. LEHTONEN, T. LITMANEN, N. KIVILUOMA
‚We have a solution': Delivering on the promise to take national responsibility for nuclear waste management

37 L. SCHWARZ
Intergenerational justice starts now: Recognizing future generations in nuclear waste management

44 R. SIERRA, K. OTT
Citizen participation in the long-term process of high-level radioactive waste disposal: Future tasks and adequate forms of participation

51 D. THEMANN
Commoning in der Standortsuche für ein Endlager?: Neue Wege kollektiven Handelns

RESEARCH

Human dignity and autonomous weapons

Ideas of 'just war' and of the appropriateness of weapons remain important issues in a world where the end of war is not foreseeable. Which moral dilemmas and ethical dimensions are posed by the development and use of lethal autonomous weapon systems?

58

INTERVIEW

Swiss repositories for nuclear waste

In September 2022 a site for a deep geological repository was proposed for Switzerland. Tim Vietor of the National Cooperative for the Disposal of Radioactive Waste (Nagra) looks ahead to steps such as underground experiments, or the specification of the layout for the deep geological repository.

72

RESEARCH

58 E. NASS
Human dignity and lethal autonomous weapon systems: A Christian ethical positioning from a Catholic point of view

65 S. A. PFAFF, A. THOMAS, A. KNIERIM
Analyse der sozialen Folgen von digitalen Technologien für Betriebe in der kleinstrukturierten Landwirtschaft

INTERVIEW

72 WITH T. VIETOR BY A. ECKHARDT
Swiss repositories for nuclear waste

REFLECTIONS

76 E. D. ROSSMANN
Book review: Lauterbach, Karl (2022): Bevor es zu spät ist

78 S. LINGNER
Book review: Schmidt, Jan Cornelius (2022): Philosophy of interdisciplinarity

80 J. GONDOLF
Book review: Ratti, Emanuele; Stapleford, Thomas (eds.) (2022): Science, technology, and virtues

82 M. BAUMANN, M. MAIA, N. WEINBERGER
Meeting report: „Privatsphäre, Datenschutz, Gemeinwohl: Ethische, rechtliche und soziale Herausforderungen der Nutzung von Gesundheitsdaten für die Forschung". Conference, 2022, Karlsruhe, DE (hybrid)

84 F. WAGNER, R. RHODIUS, M. SINGER-BRODOWSKI, F. STELZER
Meeting report: „Nachhaltig Wirken – Reallabore in der Transformation". Conference, 2022, Karlsruhe, DE

86 *TATuPDates*

TA Focus 31/3 (2022)

News for the TA community / Meldungen für die TA-Community

Jonas Moosmüller[1], Marius Albiez[1], Bernd Stegmann[2]

STUDIE

Was geht ohne Internet?

Wie würde sich ein lang anhaltender, großflächiger Ausfall digitaler Infrastrukturen auf die österreichische Gesellschaft auswirken? Mit dieser Frage hat sich das Institut für Technikfolgen-Abschätzung (ITA) beschäftigt. Die Forschenden haben untersucht, wie sich die Lage der kritischen Infrastruktur während eines mehrtägigen Internetausfalls entwickeln würde und dabei eng mit Expertinnen und Experten aus der Praxis zusammengearbeitet. Aus Sicht der Forschenden sind nicht nur die wechselseitigen Abhängigkeiten in solch einer Krise spannend, sondern vor allem die Frage des Designs zukünftiger Technologien. Derzeit würden viele Konzepte aus den Bereichen Mobilität, Gebäudesteuerung oder Gesundheit davon ausgehen, dass eine Vernetzung über das Internet ständig möglich oder zumindest kurzfristig wieder herstellbar sei. „Wenn man jedoch verhindern möchte, dass solche Systeme ausfallen, müssen wir langanhaltende Netzwerkausfälle beim Design von IT-Lösungen künftig unbedingt mitdenken“, so Jaro Krieger-Lamina aus dem Projektteam.
www.oeaw.ac.at/ita

PHD SCHOOL

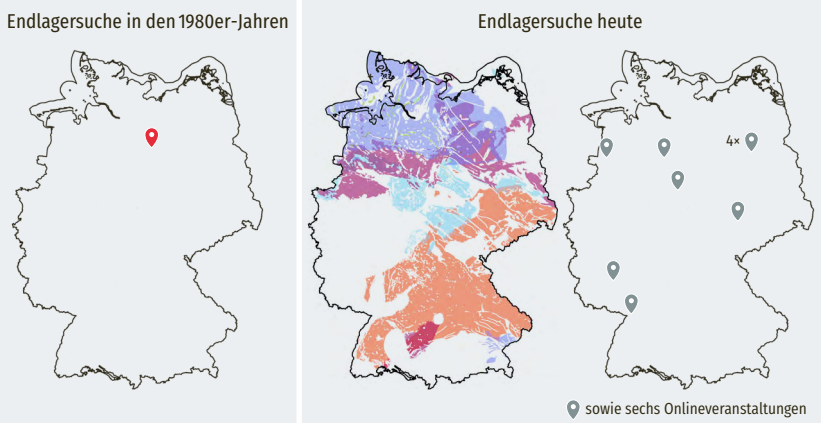
Internationales Promotionskolleg startet Testphase

Doktoranden von drei Institutionen aus den USA und Europa haben künftig die Möglichkeit, ein ‚International Doctoral Certificate in Responsible Innovation‘ zu erwerben. Angeboten wird es von dem Department of Values, Technology and Innovation der Delft University of Technology, der School for the Future of Innovation in Society der Arizona State University und dem Institut für Technikfolgenabschätzung und Systemanalyse am Karlsruher Institut für Technologie. Fragen verantwortlicher Innovationen gewännen angesichts der aktuellen Herausforderungen immer mehr an Bedeutung, so die Partner. Ziel des multidisziplinären Promotionskollegs sei es deshalb, künftigen Fachleuten eine möglichst breite Ausbildung in dem komplexen Feld zu ermöglich. Dazu besuchen die Teilnehmenden verschiedene Onlinekurse und absolvieren auch einen längeren Forschungsaufenthalt an einer der drei Institutionen. Derzeit findet eine Testrunde mit sechs Doktoranden statt. In vollem

TA-Grafik *Endlagersuche in Deutschland*

Politik und Behörden haben ab 1977 versucht, den Salzstock Gorleben als Standort für ein atomares Endlager durchzusetzen – letztlich ohne Erfolg. Seit Mitte der 2010er-Jahre wagt Deutschland einen neuen, demokratischeren Anlauf, der Bürgerinnen und Bürgern mehr Partizipation ermöglicht. (Mehr ab S. 10 in dieser Ausgabe.)

Karte Teilgebiete: Bundesgesellschaft für Endlagerung



[1] *Institute for Technology Assessment and Systems Analysis (ITAS), Karlsruhe Institute of Technology (KIT), Karlsruhe, DE*
[2] *Office of Technology Assessment at the German Bundestag (TAB), Berlin, DE*

Umfang startet das Kolleg dann im September 2023. Ziel ist es, das Programm künftig auf weitere Partnereinrichtungen weltweit auszuweiten.
www.itas.kit.edu
sfis.asu.edu
www.tudelft.nl

PODCAST

Auf Knopfdruck

3D-Druck gilt als Technologie mit enormem Potenzial für verschiedenste Anwendungsfelder. Was genau die innovative Fertigungstechnik leistet und wie sie genutzt werden könnte, fragt die Podcastserie ‚Auf Knopfdruck – 3D-Druck für die Gesellschaft von morgen'. In fünf Folgen erkundet die vom Karlsruher Exzellenzcluster *3D Matter Made to Order* produzierte Serie, was heute schon auf ‚Auf Knopfdruck' passiert und was in naher Zukunft möglich sein könnte. Dabei geht es auch darum, wie innovative Fertigungstechnologien von der Gesellschaft aufgenommen und genutzt werden. Die einzelnen rund einstündigen Episoden, moderiert von der Wissenschaftsjournalistin Isabelle Rogge, beschäftigen sich beispielsweise mit sogenannten FabLabs oder Makerspaces, in denen Bastlerinnen und Tüftler kreative Projekte verwirklichen, beleuchten Chancen der Technik für Bildung und Medizin oder setzen sich damit auseinander, wo und ob 3D-Druck industrielle Fertigung nachhaltiger machen kann.
www.3dmattermadetoorder.kit.edu/podcast_auf_knopfdruck.php

KONFERENZ

Europäische TA-Community in Karlsruhe

Angesichts der digitalen Transformation sieht sich die TA in einer Doppelrolle: Zum einen gibt sie Orientierung, in welche Richtung die Digitalisierung ganzer Lebensbereiche laufen könnte und sollte. Zum anderen ist sie selbst von Verände-

5 Fragen an Kai Gehring

MdB und Vorsitzender des Ausschusses für Bildung, Forschung und Technikfolgenabschätzung

Wann sind Sie erstmals mit der Technikfolgenabschätzung in Kontakt gekommen?
Bei meinem Einzug in den Bundestag 2005. Das Büro für Technikfolgen-Abschätzung, das TAB, hat damals Themen wie die Digitalisierung und die sozial-ökologische Transformation umfassend aufbereitet. Das TAB war also immer schon am Puls der Zeit und hat mir gezeigt: Seine Ergebnisse sollten im Parlament noch mehr gehört werden.

Welche Forschungsfrage finden Sie besonders spannend?
Das Faszinierende und Inspirierende an Technikfolgenabschätzung ist, dass sie so vielfältig arbeitet. Aber die Klimakatastrophe ist die große Überlebensfrage unserer Zeit. Das TAB beschäftigt sich derzeit unter anderem damit, wie wir unsere Klimabilanz in besonders CO_2-intensiven Bereichen wie Baumaterial, Schifffahrt oder Flugverkehr verbessern können. ‚Grünes Fliegen' wäre zum Beispiel ein Game-Changer.

Angesichts von Corona-, Klima- und Energiekrise: Ist die wissenschaftliche Beratung von Abgeordneten wichtiger denn je?
Ja, gerade in Krisenzeiten ist unabhängige, seriöse wissenschaftliche Politikberatung unerlässlich. Das TAB verschafft dem Bundestag Orientierungswissen, Handlungsperspektiven und eine gemeinsame Faktenbasis. Nur so lassen sich die großen Herausforderungen nachhaltig bewältigen.

Wissenschaft und Politik funktionieren unterschiedlich, wie können beide Seiten gut zusammenarbeiten?
Es ist wichtig, dass Klarheit über die Rollen besteht. Wissenschaft ebnet die Grundlage für unsere politischen Entscheidungen. Bei uns im Bundestag werden TAB-Berichte im Konsens von allen Fraktionen beauftragt und abgenommen. Der parlamentarische Diskurs über technologische Innovation kann also auf einer gemeinsamen Faktenbasis erfolgen.

Was würden Sie der TA empfehlen, um Erkenntnisse besser in die öffentliche Debatte einzubringen?
Das TAB leistet hervorragende Arbeit und wird uns ein wichtiger Wegweiser auch durch die 20er-Jahre sein. Wichtig ist, dass wir seine Arbeit einer breiteren Öffentlichkeit zur Verfügung stellen, um Lust auf Neues zu machen. Die proaktive Kommunikation mit der Gesellschaft ist gar nicht hoch genug einzuschätzen, auch um das Vertrauen in Wissenschaft immer wieder zu erneuern.

AUSFÜHRLICHES VIDEO-INTERVIEW UNTER www.tatup.de/youtube

Aus dem openTA-Kalender

15.–17. 03. 2023, AACHEN
STS-hub.de 2023 ‚Meeting of scholars across STS networks and associations'
sts-hub.de

08.–10. 05. 2023 (CALL FOR PAPERS BIS 17. 01.), GRAZ
Annual STS Conference Graz 2023 ‚Critical issues in science, technology and society studies'
stsconf.tugraz.at

05.–06. 06. 2022, WIEN
22. TA-Konferenz des Instituts für Technikfolgen-Abschätzung der Österreichischen Akademie der Wissenschaften
www.oeaw.ac.at/ita/detail/event/save-the-date-ta23-05-06-juni-2023

WEITERE TERMINE UNTER www.openta.net/kalender

rungsprozessen betroffen. Mit diesem komplexen Verhältnis beschäftigten sich vom 25. bis 27. Juli 2022 über 150 Wissenschaftlerinnen und Wissenschaftler aus 19 Nationen bei der 5. Europäischen TA-Konferenz ‚Digital Future(s) – TA in and for a Changing World' in Karlsruhe. Passend zum Thema fand die vom Institut für Technikfolgenabschätzung und Systemanalyse (ITAS) organisierte Tagung nicht nur vor Ort sondern parallel auf einer digitalen Plattform statt. Zentrale Beiträge, wie die drei Keynotes von Payal Arora, Jeanette Hofmann und Doris Allhutter stehen online zur Verfügung. Auch die abschließende Round-Table-Diskussion zur ‚Governance of Digital Futures' und der Frage, ob es sich dabei um ‚a Pacing Problem' handelt ist in voller Länge dokumentiert.
www.itas.kit.edu/veranstaltungen_2022_etac5

STUDIE

Bioelektronik jenseits der Medizin

Die Schweizer Stiftung für Technologiefolgen-Abschätzung (TA-SWISS) fordert, nicht-medizinische Anwendungen, die Körper und Technik miteinander verbinden, künftig spezifisch zu regulieren. In einer im Spätsommer vorgelegten Studie nehmen die Forschenden insgesamt sieben Anwendungstypen in den Blick: angefangen bei elektronischen Pflastern über implantierte Sensoren bis hin zu Exoskeletten für ganze Körperteile. Die Autorinnen und Autoren weisen auf Risiken durch bioelektronisch unterstützte Computerspiele und andere Anwendungen für Kinder und Jugendliche hin. Auch bei Bioelektronik, die direkt auf das Nervensystem einwirkt, raten sie zur Vorsicht. Konkret geht es um Anwendungen, welche die Lernfähigkeit einer Person steigern oder entspannend wirken sollen. Auch nicht-medizinische Anwendungen müssten branchenweite Standards einhalten, so das Fazit. Um Innovationen nicht zu behindern, sollte der Aufwand für die Zertifizierungen aber geringer sein als bei medizinischen Produkten.
www.ta-swiss.ch/bioelektronik

Digitale Zukünfte waren Thema der 5. Europäischen TA-Konferenz in Karlsruhe. *Quelle: Robert Fuge*

PARTIZIPATION

Beteiligung von Kindern

Für die Technikfolgenabschätzung spielt die gesellschaftliche Partizipation bei der Entwicklung von Themen, aber auch bei der Beurteilung von Technologien eine große Rolle. In welcher Form müssen und können auch Kinder und Jugendliche in partizipative Forschungsprozesse einbezogen werden? Dieser bislang weitgehend unbeantworteten Frage sind Forschende des Internationales Zentrums für Ethik in den Wissenschaften (IZEW) an der Universität Tübingen nachgegangen. Mit einem insgesamt zwölf Reflexionskriterien umfassenden Leitfaden möchten sie andere Forschende bei der Arbeit mit Kindern und Jugendlichen unterstützen. Im Fokus stehen dabei Ambivalenzen zwischen Partizipations- und Schutzrechten: Junge Menschen haben einen erhöhten Schutzbedarf, aber gemäß UN-Kinderrechtskonvention auch ein Recht auf Partizipation bei Fragen, die sie betreffen.
uni-tuebingen.de

PARLAMTENTARISCHE TA

Konferenz zu gesellschaftlichen Disruptionen

Abgeordnete und Forschende aus Deutschland und 16 weiteren Ländern haben sich am 17. Oktober 2022 in Berlin getroffen, um über den politischen und gesellschaftlichen Umgang mit Disruptionen sowie den Beitrag der TA zu diskutieren. Die thematischen Schwerpunkte der Konferenz ‚Disruption in society – TA to the rescue?' waren kritische Infrastrukturen, deren Ausfall verhindert werden muss, autonome Waffensysteme als Beispiel für IT-Systeme, die Entscheidungen mit potenziell weitreichen Konsequenzen treffen, und Wälder als Muster für einen Naturraum, der durch menschliche Aktivitäten unter Druck steht. Die internationale Konferenz wurde gemeinsam vom Ausschuss für Bildung, Forschung und Technikfolgenabschätzung sowie vom Büro für Technikfolgen-Abschätzung beim Deutschen Bundestag ausgerichtet. Beide haben in diesem Jahr die Präsidentschaft der europäischen Vereinigung von Institutionen der parlamentarischen Technikfolgenabschätzung (EPTA) inne. Das Netzwerk konnte in Berlin mit Argentinien und Luxemburg zwei neue Mitglieder aufnehmen. Parallel erschien zudem der EPTA-Report 2022, der die individuellen Perspektiven der Mitglieder auf das Thema Disruption bündelt.
www.tab-beim-bundestag.de

PUBLIKATION

Lehrbuch zur TA

Vor 20 Jahren verfasste Armin Grunwald die erste deutschsprachige Einführung in die Technikfolgenabschätzung. Nun hat der Professor für Technikphilosophie eine vollständig aktualisierte und erweiterte Neuauflage vorgelegt. Das an Studierende wie Quereinsteiger gerichtete Lehrbuch zeigt, wie TA zur verantwortlichen, demokratischen und nachhaltigen Gestaltung des technischen Fortschritts beitragen kann. Armin Grunwald nimmt dazu Praxisfelder wie Digitalisierung, Energiewende oder Gentechnik in den Blick. Er erläutert die historische Entwicklung des Fachs, geht auf Theoriebildung und -debatten ein und bietet – auch vor dem Hintergrund der Covid-19-Pandemie – einen Ausblick auf die Zukunft der TA. Die Neuauflage beschäftigt sich zudem mit aktuellen Entwicklungen, beispielsweise mit der Rolle von Zukunftsbildern bei Technikdebatten, erhöhten Mitwirkungsansprüchen aus der Zivilgesellschaft oder der wachsenden Bedeutung der Hochschullehre für die TA.

Grunwald, Armin:
Technikfolgenabschätzung. Einführung.
3., vollständig aktualisierte und erweiterte Auflage.
Baden-Baden: Nomos, 2022, 283 S.,
ISBN 9783848784981

Personalia

Quelle: OTH Regensburg/Michael Hitzek

KARSTEN WEBER hat zum 1. Oktober 2022 die Forschungsprofessur Technikfolgenabschätzung für KI-gestützte Mobilität an der OTH Regensburg übernommen. Es handelt sich dabei um die erste von drei Professuren, die die Hochschule im KI-Wettbewerb im Rahmen der Hightech Agenda des Freistaats Bayern gewonnen hatte. Weber promovierte in Philosophie. Er lehrt und forscht seit 2013 in Regensburg und war bislang Ko-Leiter des Instituts für Sozialforschung und Technikfolgenabschätzung (IST). „Gerade in Bezug auf IT allgemein und KI speziell herrscht sehr viel Unsicherheit in der Bevölkerung", so Weber. Mit seiner Forschung wolle er deswegen dabei helfen, positive Technikfolgen zu stärken und negative zu mindern oder ganz zu vermeiden.

Quelle: Dirk Hol

EEFJE CUPPEN ist die neue Direktorin des niederländischen Rathenau Instituut. Die promovierte Umweltwissenschaftlerin zeigte sich begeistert von Ihrer neuen Tätigkeit: „[… S]chon seit meiner Studienzeit war [ich] nicht nur von der Qualität der Forschung beeindruckt, sondern auch von der Rolle, die das Institut dabei spielt, gesellschaftliche Fragen im Zusammenhang mit Technologie und Innovation auf die Tagesordnung zu setzen." Neben ihrer Tätigkeit als Direktorin, die sie zum 1. Oktober 2022 aufgenommen hat, wird Cuppen weiterhin regelmäßig als Professorin für Governance of Sustainability an der Universität Leiden lehren. Als Direktorin tritt Cuppen die Nachfolge von Melanie Peters an, die im vergangenen Jahr verstorben ist.

MARCUS SCHEUREN hat im Mai 2022 die Leitung des Sekretariats des Panel for the Future of Science and Technology (STOA) im Europäischen Parlament übernommen. Er folgt auf Theo Karapiperis, der nach einer langen und erfolgreichen Karriere in den Ruhestand gegangen ist. Marcus Scheuren, der die deutsche und britische Staatsbürgerschaft besitzt, arbeitet seit über zehn Jahren als EU-Beamter in mehreren Ausschüssen des Europäischen Parlaments, etwa in den Sonderausschüssen zu den *Luxleaks*-Steuerenthüllungen und zu den *Panama Papers* sowie im Ausschuss für Industrie, Forschung und Energie. Von 2020 bis 2022 leitete er das Sekretariat des Sonderausschusses des Europäischen Parlaments für Künstliche Intelligenz im digitalen Zeitalter.

10

SPECIAL TOPIC

The future of radioactive *waste disposal:*

What are the developments and challenges after site selection?

Die Zukunft der Endlagerung:

Was sind die Entwicklungen und Herausforderungen nach einer Standortentscheidung?

Edited by U. Smeddinck, A. Eckhardt, S. Kuppler

https://doi.org/10.14512/tatup.31.3.10

TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis
Journal for Technology Assessment in Theory and Practice

oekom

INTRODUCTION

Toward a repository for high-level radioactive waste: Perspectives and approaches

Ulrich Smeddinck*,[1], Anne Eckhardt[2], Sophie Kuppler[1]

Abstract • The future is unpredictable. Under these circumstances, how can we plan and construct a nuclear waste repository that is supposed to safely store the waste for up to a million years – an endeavor that may in itself take more than a hundred years? In this introduction to the special topic on the future of nuclear waste disposal, we take a first look at this question by searching the literature for answers and by giving a short overview of the current status of site selection in different countries, including possible challenges.

***Auf dem Weg zum Endlager**: Perspektiven und Ansätze*

Zusammenfassung • *Die Zukunft ist unvorhersehbar. Wie können wir unter diesen Umständen ein Endlager für nukleare Abfälle planen und errichten, das die Abfälle für bis zu eine Million Jahre sicher aufbewahren soll – ein Unterfangen, das an sich schon mehr als hundert Jahre dauern kann? In dieser Einleitung zum Schwerpunktheft über die Zukunft der Atommüllentsorgung werfen wir einen ersten Blick auf diese Frage, indem wir in der Literatur nach Antworten suchen und einen kurzen Überblick über den aktuellen Stand der Standortwahl in verschiedenen Ländern geben, einschließlich möglicher Herausforderungen.*

Keywords • *nuclear waste, future, public participation, disposal policy*

* *Corresponding author: ulrich.smeddinck@kit.edu*
[1] *Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology, Karlsruhe, DE*
[2] *risicare GmbH, Zollikerberg, CH*

https://doi.org/10.14512/tatup.31.3.11
Recieved: Oct. 17, 2022; revised version accepted: Nov. 07, 2022;
published online: Dec. 16, 2022 (editorial peer review)

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler. https://doi.org/10.14512/tatup.31.3.10*

Introduction

The stupendous time perspective of one million years, which is often associated with the disposal of high-level radioactive waste, opens up an immensely wide temporal horizon and an irritatingly vast future space. The dimensions of this period are significant because of the persistence of the radioactive hazard that in the case of disposal in an underground repository requires stability of geological formations encasing it. It is a problem, a task, a project that can to some extent be quantified and thought through, but that in a way is also unimaginable or even incomprehensible. Nevertheless, there is a need for action – in the distant future, but more urgently in the present.

The future can be far away and present at the same time. This is certainly true for the final disposal of high-level radioactive waste. According to the law the siting decision for a final repository in Germany should be taken in the year 2031 – though this time frame is considered unrealistic by now (see below). What appears to be the future in this country has already dawned in Switzerland. In our neighbouring country, a site has been proposed in September 2022. This marks the beginning of a new phase with its specific tasks and challenges. It is also very interesting to look at Finland, which was the first country in the world ever to realize a deep geological repository for highly radioactive waste from the civil use of nuclear energy. The future developments in Switzerland, the way emerging problems are handled there and the way they were handled in Finland – from a technical and societal point of view – thus (still) offer interesting insights for all the others who still have this phase ahead of them and want to prepare themselves.

The confrontation with the future

In general, dealing with the future is not easy. Especially because it has not yet occurred, because it is not yet here, not yet manifesting itself. What can be dealt with are ideas about the future. Here we will take a brief look at the bridge that connects the past future with the futures that are in front of our eyes, with an emphasis on the possibilities and opportunities of dealing with the future (for other possibilities for bridging this gap see Grunwald et al. 2020).

The future is being made – is the future being made? The impression that human endeavor for the future reaches its limits arises above all when one looks in retrospect at the end and swansong of developments and new technologies that are abolished or perish in another way. A technology that was future ends. What was future ends. The present that was future is not the present that was once expected – not least because former futures ended prematurely (Radkau 2017). What stays is the task of safely and responsibly taking care of the technology's remains; for example, to end the peaceful use of nuclear energy in Germany, which was once considered a great hope for the future in this country (Radkau and Hahn 2013). Nuclear power plants need to be dismantled and the waste taken care of. Unexpected events or unforeseeable interactions in and in between actions and events raise doubts that the future can be made.

The roots of the approach to accompany new technological developments in an anticipatory way in order to avoid undesirable side-effects and consequences have themselves become historical: Since 1957 the Study Group for Systems Research has established interdisciplinary and practice-oriented policy advice based on innovative models of thought and research concepts (Brinckmann 2006, p. 14). Technology assessment (TA) has a broader approach and also draws on other sources. If technological progress is not without its downsides, then the "forward-looking consideration of the possible consequences in their entirety […] is called for in order to avoid illusions and blind wishful thinking, to enable well-informed and reflected decisions and to promote the responsible shaping of technological change and the use of its products" (Grunwald 2022, p. 19, own translation). One of the hopeful innovative approaches that TA is promoting today is vision assessment (Frey et al. 2022). The empirical exploration of visions as socio-epistemic practices responds to the ubiquity of visions of the future and their efficacy in all areas of society, in science and politics as well as in civil society and mass media. The research group 'Repository Research and Long-term Governance' at the Institute for Technology Assessment and Systems Analysis (ITAS) in Karlsruhe – to which two of the three authors of this text belong – focuses on this topic (Hocke et al. 2022).

Also in politics, the question of how to deal with the future is present: The Federal Government of Germany is currently building structures to deal more effectively with the future and future issues in general. At times, techno-optimism can be observed, such as when the 'digital minister' Volker Wissing pointedly demands: "We need to stop discussing visions of the future and move on to concrete implementation" in order to resolve the existing digitalisation backlog (Voß and Rusch 2022, own translation). On the other hand, however, are the other, broader activities: Chancellor Scholz has convened a new 'future council', which has started its work. In addition, a unit at the Federal Chancellery is being tasked with the new approach of strategic foresight. Furthermore, following scientific recommendations, a separate 'future laboratory' could be set up, in which, for example, far-reaching decisions of the government would be examined in advance for their 'future compatibility' (Rusch and Ronzheimer 2022).

Overall, also the scholarly perspectives on the future are diverse: from a philosophical perspective, Hans Blumenberg (1986) has focused on and thought through the mortification that every single human being has to live with the fact that the world and humanity will simply continue to exist and carry on after his or her death. The publicist Alan Weisman (2009) took an even more radical approach: He describes the world after the extinction of humanity. As concretely as it is described, as abstractly monstrous or remote, even unbelievable, it appears to human thinking. What is relieving, perhaps even comforting, is the idea that there will be no human being left. Only animals and plants. And the nuclear waste.

In a novel, the writer Annette Hug approaches the question of how to deal with the future fictitiously and debates how methods can be developed "to document knowledge about the dangers of nuclear waste and reliably pass it on from generation to generation" (Hug 2021, cover text, own translation). In the international debate, different approaches to this can be found ranging from atomic priesthoods to markers and art projects (NEA/RWM 2012; Grunwald 2018)

Has jurisprudence lacked imagination or have the wrong reference points simply been set? In any case, law and jurisprudence do not find it easy to deal with questions about the future. Almost simultaneously with the introduction of the state goal of protecting the livelihoods of future generations, Michael Kloepfer (1993) popularized the metaphor of the impending eco-dictatorship. In 2013, Klaus Ferdinand Gärditz (2013, p. 16) argues for a stronger focus of environmental legislation on present-day problems. On the other hand, with its climate decision of 2021, the German Federal Constitutional Court strengthened the intertemporal freedom rights of future generations and the importance of effective climate protection.[1] More generally, Jens Kersten and Elisabeth Kaupp ask "How open to the future is the Basic Law?" (Kersten and Kaupp 2022, p. 473, own translation).

In sum, the stale taste remains that an entire generation, according to the publicist Bernd Ulrich (2019, p. 82), has not done enough for the future, for environmental and climate protection, despite knowing better: "If you look at the totality of all ecological measures in Germany, you will then hardly discover the

1 Decision of the Federal Constitutional Court of March 24, 2021-1 BvR 2656/18, Decisions Vol. 157, pp. 30–177.

https://doi.org/10.14512/tatup.31.3.11

contours of a turning point forward, but rather the escape routes of politics from the people and even more from the economy" (ibid., p. 200, own translation).

The sociologist and contemporary diagnostician Heinz Bude noted an "inversion of the direction of fear" in the "younger generation's perception of reality" (Lobe 2022: p. 21, own translation; Kaltenbrunner 2022): The worst is not (any longer) over; the worst is yet to come! In other words: "The perpetuated crisis narrative changes something in our perception and perspective: The future is no longer a space of possibility, but a space of danger. Not something to be actively shaped, but something to be prevented" (Lobe 2022, p. 21, own translation). In fact, a dystopia has come true in Zaporizhzhya: The largest nuclear power plant in Europe is being shelled in the war between Russia and Ukraine (col/AFP 2022). No wonder, young Germans would rather live in the past than in the future (KIG/dpa 2022). And yet, work must continue on the project to realize a final repository for highly radioactive waste in Germany, …

The worst is not (any longer) over; the worst is yet to come!

Long-term project on final disposal

… in many other countries, and for a very long time.

The time scales and future perspectives for the final disposal of high-level radioactive waste in Europe are currently very diverse. Nations such as Finland, the Netherlands or Germany have each chosen their own concepts and procedures to realize final disposal. The time spans over which the disposal programmes are to be realized differ significantly in some cases.

In Finland, the construction of the ONKALO repository for high-level radioactive waste, which was approved in 2015, is already well advanced. Operation is expected to start in the mid-2020s (Posiva Oy 2022). In France, the implementer Andra is expected to submit a construction application for the central repository Cigéo in the near future. Commissioning of this facility is planned for around 2040 (Nagra 2022 a). In Switzerland, as already mentioned, the implementer Nagra submitted a site proposal in September 2022. If this proposal successfully completes all further licensing steps, from today's perspective operation of the deep geological repository for high-level radioactive waste can begin around 2060. Nagra expects to be able to close the repository in about 100 years, around 2115 (Nagra 2022 b). However, since Switzerland provides for a basically unlimited monitoring phase after completion of emplacement, closure may also take place much later. In the Netherlands, high-level waste is temporarily stored in a surface repository for a period of approximately 100 years until a deep geological repository is available. The development of a storage concept and the search for a suitable site for final disposal are – according to the Centrale Organisatie Voor Radioactief Afval (COVRA N. V.) – currently still in the research phase. The spectrum of plans for the commissioning of the repositories in the four countries under consideration thus ranges in time from about 2025 to 2125 or beyond. Further decades will pass before the repositories are closed.

In Germany, the Bundesgesellschaft für Endlagerung (BGE) has been mandated "to identify a site in the Federal Republic of Germany with the best possible safety for a final disposal facility for domestically produced high-level radioactive waste by means of a participative, science-based, transparent, self-questioning and learning process"[2]. This task was supposed to be solved by the year 2031 (BGE 2022). However, in the meantime, somewhen between 2046 and 2068 has been proposed by the BGE as realistic timeframe. This does not come as a surprise to various experts, who have considered this timetable unrealistic already before – also against the background of experience in other European countries – and a significantly longer timeframe is expected for site selection even now. For example, an expert who advised the German commission 'Lagerung hoch radioaktiver Abfallstoffe' expects that it will take considerably more than 100 years after the start of the site selection process until the German repository for high-level radioactive waste is finally closed and decommissioned (KLA 2016).

In Germany, this is followed by a period of 500 years during which monitoring should take place and retrievability be ensured. By the time the repository will be finally closed, many generations of specialists will have been involved in the endeavor. In order to ensure safety and security, for example, a passing on of knowledge and skills is essential although some of the technologies which are used at the site may be outdated in the future.

Impact of current events and developments

A lot can happen in 100 years, let alone 600 or more years. The present demonstrates that profound changes are possible even in a short time, which can have an impact on the final disposal of high-level radioactive waste.

2 Repository Site Selection Act of 05. 05. 2017 (BGBl. I p. 1074), as last amended by Article 1, Section 2 of the Act of 07. 12. 2020 (BGBl. I p. 2760). Available online at https://www.gesetze-im-internet.de/standag_2017/StandAG.pdf (in German), last accessed on 17. 10. 2022.

The war in Ukraine has clearly shown that interim storage facilities and facilities for the treatment of high-level radioactive waste can become targets of attacks in the event of an armed conflict (IAEA 2022a, IAEA 2022b). Deep geological repositories offer more protection in the event of war than surface facilities. It is therefore possible that the experience of war will ultimately lead to an effort to accelerate the disposal of high-level radioactive waste in deep repositories.

Climate change is increasingly leading to extreme weather events worldwide and associated natural hazards such as drought, forest fires, floods and landslides (IPCC 2022). The need to reduce greenhouse gas emissions has thus become more obvious; the urgency is felt politically more strongly than before. The European Union aims to make Europe the first climate-neutral continent by 2050. In this context, it has, among other things, classified nuclear energy as sustainable in 2022 – provided that a detailed plan is in place to bring a final repository for the high-level radioactive waste from nuclear power plants into operation by 2050 (European Commission 2022). In the European Union, this development also increases the urgency of putting final repositories for high-level radioactive waste into operation.

New technological developments facilitate the exploration of the geological subsurface and the construction and operation of repositories. Geological data are increasingly stored on central platforms; developments in information technology enable more differentiated evaluation of data sets. The feasibility and economic efficiency of underground structures is improving due to new investigation and tunnelling techniques (e.g. American company for infrastructure and tunnel construction services *The Boring Company*); robotics offers perspectives for the safe emplacement of radioactive waste in a repository (Andra 2019). The construction and operation of repositories could thus be accelerated.

Current crises such as the COVID-19 pandemic, the war in Ukraine and the consequences of climate change tie up considerable societal resources. Therefore, it stands to reason that society might give lower priority to final disposal in the future than is currently the case. Resources dedicated for final disposal would then be diverted to achieve other goals that are judged to be more important and urgent – such as mitigating climate change or securing societal peace.

Involving young people in waste management within the framework of participation is proving difficult in many cases at present. For many adolescents and young adults, the disposal of highly radioactive waste is apparently not a topic they particularly want to get involved in – or those responsible for public participation at project developers and authorities do not succeed in addressing them (Schult and Verbarg 2022; NEA/RWM 2021). It is therefore conceivable that the next generation will judge and shape final disposal differently than those who currently assume responsibility for this task.

All those involved in shaping final disposal as a learning process (Röhlig et al. 2021) will face significant challenges with such changed social framework conditions and assessments. Considering the 600-year schedule, one might despair and concede that it is impossible to plan ahead for such a far-reaching future. Still, it seems worthwhile and even necessary to prepare and reflect on the repercussions our current actions could have on the future. For example, what could be characteristics of a resilient institutional set-up for long-term governance that makes it at least more likely that someone will be there 400 years from now, who is able to read and interpret the monitoring data? Checks and balances in decision-making in combination with a web of research activities could be part of the answer (Kuppler and Hocke 2019). This Special topic contributes to exploring further approaches to thinking about how the present shapes those future challenges and how they in turn resonate today.

What could be characteristics of a resilient institutional set-up for long-term governance?

Overview of contributions

The fact that looking into the future and dealing with it is not easy is also reflected in the submissions to our call. Hardly any contribution is dedicated to a situation in the future. The majority of the contributions continue current developments or seek to derive conclusions from current observations. What is striking is the shift into a reflection on time, its duration and its power. When is the right time to begin the future? In our opinion, it is now. This Special topic is an invitation to start a discussion on the many questions that should be thought through and dealt with in time.

Which timescales should we talk about? Margarita Berg and Thomas Hassel point out in their contribution that when discussing about high-level radioactive waste in Germany, we mostly talk about the near and the far distant future. What we neglect is the medium-term period of 500 years after closure of the repository, when many decisions still need to be made. They suggest that one reason may be that it is much easier to talk about the future when it is fixed to a specific date (2031) than when it stands in relation to another, undetermined date (500 years after closure). One million years after closure seems to be an exemption, as it is an incredible and intangible amount of time. Looking at existing approaches to communicate time, they suggest

 https://doi.org/10.14512/tatup.31.3.11

that focusing on passing knowledge from generation to generation could be part of the solution and help with thinking about time. They consider 'time literacy' to be an important aspect of nuclear waste management.

Sacha Frenay and Céline Parotte also take up the issue of time, highlighting its framing power in choosing a waste management strategy, using Belgium as an example. They suggest that the concept of 'timeprints' is helpful in understanding how stakeholders frame different waste management options and how the timeprints act as a form of 'tacit governance.' Based on a Delphi study with 193 participants they identify four timeprints for the Belgian case: the 'trajectorism', the 'promise economy', 'radioactive waste identity' and the 'multi-situated.' In the identification of the timeprints, (economic) promises, the naming of radioactive objects, and the idea where the waste should be stored play a role. They point out that the silences that accompany these timeprints, as well as their interactions and entanglements, influence current radioactive waste programs. Therefore, they believe it is worthwhile to look at such timeprints in other countries as well.

That nuclear waste should be disposed of within one's own borders is an established paradigm in many countries. Matti Kojo, Markku Lehtonen, Tapio Litmanen and Niina Kiviluoma take a closer look at this notion, by framing it as an 'umbrella promise' – a form of techno-scientific promise – and trace its construction and transformation in Finland. They identify three developments that are changing this promise: (1) the lack of cooperation among different nuclear power companies, (2) the idea of 'international responsibility' that includes a network of repositories for imported waste in Finland, and (3) the idea of small nuclear reactors at household level that raises the issue of decentralized disposal. They conclude that it is worth taking a closer look at techno-scientific promises beyond hype cycles to better understand and regulate technologies.

Lucas Schwarz discusses in his paper how intergenerational justice can best be addressed in the various stages of a site selection process (pre-selection, selection, post-selection). Drawing on ideas from the debate on environmental justice, he explores the hypothesis that intergenerational justice can best be achieved by ensuring "high standards for procedure, distribution, and recognition" (this TATuP issue, p. XX). Based on a quantitative public survey and qualitative observations, he concludes that the best way to create intergenerational justice is to ensure a high-quality site selection process today. Another measure would be to involve an institution such as the 'Council of the Young Generation', whose task would be to keep the interests of future generations present in the current decision-making processes. This would also mean that society acts and is recognized as a corrective authority in a system of 'checks and balances.'

Another aspect of participation is the subject of the contribution of Rosa Sierra and Konrad Ott. Using the two principles 'justice' and 'safety', they discuss what kind of participation can be considered appropriate in the different phases of the site selection process, referring to Habermas' ideas of deliberative governance. Based on the literature and a workshop on participatory aspects of procedural justice, they discuss how and with what goal the public should be involved in different cases: In the case of compensations for negative impacts, the public should be given decision-making power when issues such as quality of life and economic impacts are being negotiated. When making safety-relevant decisions, such as to close a repository, they argue that in democracies, decision-making power should rest with elected representatives because they are best able to weigh aspects of justice and safety.

In her contribution, Dörte Themann discusses whether the current institutionalization processes in the field of nuclear waste management in Germany show signs of logics inherent in Elinor Ostrom's ideas on commons governance. She draws on participatory observations of current public events in the context of the German site selection process and analyzes the extend, to which each of these meets eight different criteria that Ostrom identified as key to successful and long-term commons governance. She shows that, in particular, the desire for civil society to self-organization as a corrective can be interpreted as a form of independent control that corresponds with the idea that nuclear waste is a shared responsibility for which the best solution must be found. She concludes that principles of commons governance may prove helpful in the long-term management of radioactive waste, such as trust-building, adaptability and longevity.

This Special topic contributes to exploring further approaches to thinking about how the present shapes those future challenges and how they in turn resonate today.

In the interview, Tim Vietor provides information about the future of deep geological disposal in Switzerland and reflects on the role of the implementer Nagra in this process. In September 2022, Nagra submitted a site proposal for a repository for low-, intermediate- and high-level radioactive waste. With the expected end of the site selection process, new challenges arise. New tasks for research and regional participation are emerging – and the implementer also faces changes, such as a large construction site.

Funding • This work received no external funding.
Competing interests • The authors declare no competing interests.

References

Andra – Agence nationale pour la gestion des déchets radioactifs (2019): Rencontre avec SAM, le robot autonome conçu pour la surveillance de Cigéo. Available online at https://www.andra.fr/rencontre-avec-sam-le-robot-autonome-concu-pour-la-surveillance-de-cigeo, last accessed on 02. 11. 2022.

BGE – Bundesgesellschaft für Endlagerung (2022): Site selection procedure. Available online at https://www.bge.de/en/repository-search/site-selection-procedure/, last accessed on 02. 11. 2022.

Blumenberg, Hans (1986): Lebenszeit und Weltzeit. Frankfurt a. M.: Suhrkamp.

Brinckmann, Andrea (2006): Wissenschaftliche Politikberatung in den 60er Jahren. Die Studiengruppe für Systemforschung, 1958 bis 1975. Baden-Baden: Nomos. https://doi.org/10.5771/9783845271095

col/AFP (2022): Internationale Atomaufsicht auf dem Weg zum AKW Saporischschja. In: Spiegel Online, 29. 8. 2022. Available online at https://www.spiegel.de/ausland/ukraine-krieg-iaea-team-auf-dem-weg-zu-atomkraftwerk-saporischschja-a-38127d27-f041-430f-af10-875c96e475c9, last accessed on 02. 11. 2022.

European Commission (2022): Questions and answers on the EU Taxonomy Complementary Climate Delegated Act covering certain nuclear and gas activities. Available online at https://ec.europa.eu/commission/presscorner/detail/en/QANDA_22_712, last accessed on 02. 11. 2022.

Frey, Philipp; Dobroć, Paulina; Hausstein, Alexandra; Heil, Reinhard; Lösch, Andreas; Roßmann, Maximilian; Schneider, Christoph (2022): Vision assessment. Theoretische Reflexionen zur Erforschung soziotechnischer Zukünfte. Karlsruhe: KIT Scientific Publishing. https://doi.org/10.5445/KSP/1000142150

Gärditz, Klaus (2013): Zeitprobleme des Umweltrechts. In: Zeitschrift für Europäisches Umwelt- und Planungsrecht (EurUP) 11 (1), pp. 2–16.

Grunwald, Armin (2018): Technikzukünfte als Forschungsgegenstand der Geistes- und Sozialwissenschaften. In: Andreas Böhn and Andreas Metzner-Szigeth (eds.): Wissenschaftskommunikation, Utopien und Technikzukünfte. Karlsruhe: KIT-Scientific Publishing. https://doi.org/10.5445/IR/1000080319

Grunwald, Armin (2022): Technikfolgenabschätzung. Einführung. Baden-Baden: Nomos.

Grunwald, Armin; Schäfer, Martina; Bergmann, Matthias (2020): Neue Formate transdisziplinärer Forschung. Ausdifferenzierte Brücken zwischen Wissenschaft und Praxis. In: GAIA 29 (2), pp. 106–114.

Hocke, Peter; Kuppler, Sophie; Smeddinck, Ulrich; Hassel, Thomas (eds.) (2022): Technical monitoring and long-term governance of nuclear waste. Baden-Baden: Nomos.

Hug, Annette (2021): Tiefenlager. Heidelberg: Wunderhorn.

IAEA – International Atomic Energy Agency (2022 a): Update 96 – IAEA Director General statement on situation in Ukraine. Available online at https://www.iaea.org/newscenter/pressreleases/update-96-iaea-director-general-statement-on-situation-in-ukraine, last accessed on 02. 11. 2022.

IAEA – International Atomic Energy Agency (2022 b): The safety, security and safeguards implications of the situation in Ukraine. Available online at https://www.iaea.org/newscenter/statements/the-safety-security-and-safeguards-implications-of-the-situation-in-ukraine, last accessed on 02. 11. 2022.

IPCC – Intergovernmental Panel on Climate Change (2022): Climate change 2022. Impacts, adaptation and vulnerability. Summary for policy makers. Available online at https://www.ipcc.ch/report/ar6/wg2/, last accessed on 02. 11. 2022.

Kaltenbrunner, Robert (2022): Enge, Gedränge, Protest. Was wir aus Städten machen – und sie aus uns. In: Der Tagesspiegel Online, 01. 05. 2022. Available online at https://www.tagesspiegel.de/meinung/enge-gedrange-proteste-was-wir-aus-stadten-machen-und-sie-aus-uns-464298.html, last accessed on 02. 11. 2022.

Kersten, Jens; Kaupp, Elisabeth (2022) Die Verfassung einer prospektiven Gesellschaft. Wie zukunftsoffen ist das Grundgesetz? In: Juristische Schulung 2022 (JuS), pp. 473–482.

Kloepfer, Michael (1993): Auf dem Weg zur Ökodiktatur? In: Jahrbuch Ökologie 1993. Stuttgart: Hirzel, pp. 200–205.

Kuppler, Sophie; Hocke, Peter (2019): The role of long-term planning in nuclear waste governance. In: Journal of Risk Research 22 (11), pp. 1343–1356. https://doi.org/10.1080/13669877.2018.1459791

KIG/dpa (2022): Viele junge Menschen würden lieber in der Vergangenheit leben. In: Spiegel-Online, 23. 04. 2022. Available online at https://www.spiegel.de/panorama/viele-junge-menschen-wuerden-lieber-in-der-vergangenheit-leben-a-23468f41-2a1e-46b5-91bf-f9ed76d49546, last accessed on 02. 11. 2022.

KLA – Kommission Lagerung hoch radioaktiver Abfallstoffe (2016): Ablaufplan und Zeitbedarf für das Standortauswahlverfahren und die Einrichtung eines Endlagers (zu K-Drs. 160 b/160 c). Beratungsunterlage von Herrn Prof. Dr. Thomauske für die 27. Sitzung der Kommission. s. l.: s. n. Available online at https://www.bundestag.de/endlager-archiv/blob/422476/1eb4d9e381ab4006f572d1076e9d6ee8/drs_222-data.pdf, last accessed on 02. 11. 2022.

Lobe, Adrian (2022): Regierungen im permanenten Krisenmodus. Mit politischem Mut lassen sich neue Ideen umsetzen. In: Der Tagesspiegel Online, 11. 08. 22. Available online at https://www.tagesspiegel.de/kultur/utopien-sind-uberlebensnotig-mit-politischem-mut-lassen-sich-neue-ideen-umsetzen-8540395.html, last accessed on 02. 11. 2022.

Nagra – Nationale Genossenschaft für die Lagerung radioaktiver Abfälle (2022 a): How far advanced are disposal programmes in other countries? Available online at https://nagra.ch/en/knowledge-centre/have-repositories-been-constructed/, last accessed on 02. 11. 2022.

Nagra (2022 b): What is the procedure for identifying the most suitable repository site? Available online at https://nagra.ch/en/knowledge-centre/site-selection-process/, last accessed on 02. 11. 2022.

NEA/RWM – Nuclear Energy Agency/Radioactive Waste Management (2013): The preservation of records, knowledge and memory (RK & M) across generations. Improving our understanding. Available online at https://www.oecd-nea.org/rwm/reports/2013/rwm-r2013-3.pdf, last accessed on 02. 11. 2022.

NEA/RWM (2021): The forum on stakeholder confidence report on dialogue in the long-term management of radioactive waste. Available online at https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=NEA/RWM/R(2020)1&docLanguage=En, last accessed on 02. 11. 2022.

Posiva Oy (2022): Repository in ONKALO. Eurajoki: Posiva Oy. Available online at https://www.posiva.fi/en/index/finaldisposal/researchandfinaldisposalfacilitiesatonkalo.html, last accessed on 02. 11. 2022.

Radkau, Joachim (2017): Geschichte der Zukunft. Prognosen, Visionen, Irrungen in Deutschland von 1945 bis heute. München: Hanser.

Radkau, Joachim; Hahn, Lothar (2013): Aufstieg und Fall der deutschen Atomwirtschaft. München: oekom.

Röhlig, Klaus-Jürgen; Brendler, Vinzenz; Hocke, Peter; Mbah, Melanie; Smeddinck, Ulrich; Sträter, Oliver (2021): „Lernendes Verfahren im Standort-

auswahlverfahren“. Empfehlungen und Angebote der Deutschen Arbeitsgemeinschaft Endlagerforschung (DAEF). Available online at https://www.endlagerforschung.de/assets/daef_lernverf_thesenpapier_final_2021-05-12.pdf, last accessed on 02.11.2022.

Rusch, Lina (2022): Neue Zeiten fest im Blick. Kann die Ampel Zukunft? In: Der Tagesspiegel Online, 29.08.2022. Available online at https://www.tagesspiegel.de/politik/kann-die-ampel-zukunft-8589997.html, last accessed on 02.11.2022.

Rusch, Lina; Ronzheimer, Manfred (2022): Neue Zeiten fest im Blick. Kann die Ampel Zukunft? In: Der Tagesspiegel Online, 30.8.2022. Available online at https://www.tagesspiegel.de/politik/kann-die-ampel-zukunft-8589997.html, last accessed on 02.11.2022.

Schult Jannik; Verbarg, Tim (2022): Nur weil es draufsteht, muss es nicht drin sein. Die Workshopreihe „Mitreden bei der Endlagersuche“ für die junge Generation. Karlsruhe: ITAS-TRANSENS-Paper No. 4, S. 1–19. https://doi.org/10.5445/IR/1000150066

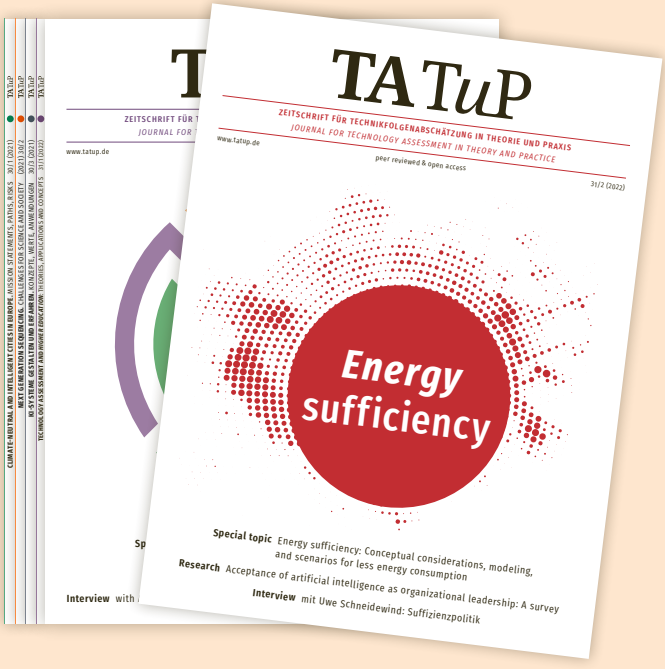
Voß, Oliver; Rusch, Lina (2022) Volker Wissing zur Digitalstrategie. „Raus aus der Diskussion von Zukunftsvisionen“. In: Der Tagesspiegel Online, 31.08.2022. Available online at https://www.tagesspiegel.de/politik/raus-aus-der-diskussion-von-zukunftsvisionen-8590447.html, last accessed on 02.11.2022.

Weisman, Alan (2009): Die Welt ohne uns. Reise über eine unbevölkerte Erde. München: Piper.

APL. PROF. DR. ULRICH SMEDDINCK
is senior researcher at ITAS since 2019. As law scientist he is a member of the Law School at the University of Halle-Wittenberg. He is interested in regulation, environmental law and transdisciplinarity. Inside the research cluster ‘Transdisciplinary Research on High-Level Radioactive Waste Management in Germany’ (TRANSENS) he is working as project leader.

DR. ANNE ECKHARDT
is managing director of risicare GmbH. She advises on safety, risk and uncertainty and has been involved in various committees on nuclear safety in Switzerland. Currently she is working as deputy spokesperson and researcher in the project ‘Transdisciplinary Research on High-Level Radioactive Waste Management in Germany’ (TRANSENS).

DR. SOPHIE KUPPLER
is head of the research group ‘Radioactive Waste Management as a Socio-Technical Project’ at ITAS/KIT since October 2022. She has been working on questions regarding technology conflicts, nuclear waste governance and participation since 2009.



Call for Special topic editors

Researchers who are interested in editing a Special topic in TATuP – Journal for Technology Assessment in Theory and Practice may submit their proposals in English language to redaktion@tatup.de **by 31 January 2023**.

On the journal website you will find full information on the call for Special topics and on how to submit your proposal.

By editing a TATuP a Special topic you can make an important contribution to debates of technology assessment and at the same time strengthen your field of research!

We are looking forward to receiving your proposals!

Step by step:
online guide to submitting your Special topic proposal

TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis
Journal for Technology Assessment in Theory and Practice

oekom

RESEARCH ARTICLE

Challenges in communicating the future of high-level radioactive waste disposal: What future are we talking about?

Margarita Berg*,[1], Thomas Hassel[2]

Abstract • Of the three main time horizons specified in the German Repository Site Selection Act (the year 2031, 500 years after closure and one million years), the current public discourse largely neglects the "medium term". However, many important choices will have to be made during this period. The article discusses different conceptions of time that could help to improve public understanding of the time horizons for high-level radioactive waste disposal and the decisions that still lie ahead.

***Herausforderungen in der Kommunikation über die Zukunft der Entsorgung hochradioaktiver Reststoffe**: Über welche Zukunft sprechen wir?*

Zusammenfassung • *Von den drei wesentlichen im Standortauswahlgesetz genannten zeitlichen Horizonten (das Jahr 2031, 500 Jahre nach Verschluss und eine Million Jahre) wird die mittlere Perspektive im gegenwärtigen öffentlichen Diskurs meist vernachlässigt. Allerdings werden in diesem Zeitraum viele wichtige Entscheidungen zu treffen sein. Der Artikel diskutiert unterschiedliche Zeitkonzepte, die dabei helfen könnten, das öffentliche Verständnis für die Zeithorizonte der Entsorgung hochradioaktiver Reststoffe sowie die noch anstehenden Entscheidungen zu verbessern.*

Keywords • *conceptions of time, future studies, high-level radioactive waste disposal, science and art*

* *Corresponding author: berg@philsem.uni-kiel.de*
[1] *Philosophisches Seminar, Christian-Albrechts-Universität zu Kiel, Kiel, DE*
[2] *Institut für Werkstoffkunde, Leibniz Universität Hannover, Hannover, DE*

https://doi.org/10.14512/tatup.31.3.18
Recieved: Jun. 10, 2022; revised version accepted: Oct. 21, 2022;
published online: Dec. 16, 2022 (peer review)

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler. https://doi.org/10.14512/tatup.31.3.10*

Introductory observations

Conceptions of time are highly relevant in addressing the subject of high-level radioactive waste disposal. However, talking about the future (and especially the far future) is extremely complex, mostly hypothetical and riddled with complications and imprecisions. This article aims to determine which time horizons of the future are currently addressed in the discourse on high-level radioactive waste disposal and where communication could be improved. These deliberations were originally inspired by the site selection process in Germany but will include insights from other countries where appropriate.

Following § 1 of the German Repository Site Selection Act[1], there are three different time horizons which might be broken down into smaller sections if appropriate. Germany aims to have located a site for final storage of high-level radioactive waste by 2031, the waste is supposed to be recoverable for 500 years after the repository is closed, and the selected site must be the safest one for isolating the high-level radioactive waste from the biosphere for one million years. The goal of 2031 was set due to the expiring licences for the interim storage facilities and the need to find a final storage site before public awareness of this problem dwindles after the end of nuclear power use in Germany. Recoverability was included in the German Repository Site Selection Act due to the problems in the Asse repository for low- and

1 Repository Site Selection Act of 05. 05. 2017 (BGBl. I p. 1074), as last amended by Article 1 of the Act of 07. 12. 2020 (BGBl. I p. 2760). Available online at https://www.gesetze-im-internet.de/standag_2017/StandAG.pdf (in German), last accessed on 17. 10. 2022.

medium-level radioactive waste. It is assumed that knowledge of the storage facility will not last for more than 500 years after closure. The containers should be recoverable during that period. The one million years of safe storage is based on calculations of half-life and uncritical radiation levels (Wollenteit 2019).

This broad range of future time horizons (from a few years to one million years) poses interesting challenges for the communication on high-level radioactive waste disposal. However, two of these time horizons are currently discussed almost exclusively. News reports following the interim report on suitable subareas (BGE 2020) referred amply to the year 2031 (which local politicians in particular often described as 'a long time from now') and to the one million years (albeit in a very abstract way). Similarly, the first 'Streitgespräch' (a disputation format

possible solutions for safe final disposal, at least for the near future. Such safety promises for functional endurance of the technical system become more difficult if it is not subject to maintenance, as is the case with the final storage containers after closure of the section. In order to be able to describe the future behaviour of this system, data is needed that depicts changes in properties over time, which can then be extrapolated into the future. The quality of the data and the temporally exact system development are extremely important to keep uncertainties and insecurities in the statements on future system behaviour as small as possible. It is precisely in the consideration of the 'medium term', which appears to be the most undefined and obscure in the public discourse, that the most accurate knowledge of the system's behaviour is required.

Statements about the future development of a system become possible by looking into the past.

established by the German National Citizens' Oversight Committee) discussed mainly the next decade in the conversation itself, with the one million years brought up afterwards by a question from the audience. In contrast to the generational approach in France (see below), there have been no specific attempts to facilitate public understanding of the different time horizons in Germany so far, with the exception of a short TV documentary (Geiger 2021).

It is perhaps understandable that discussions currently focus on the year 2031, because it is reasonably soon and deals with the initial step of finding a site, and on the period of one million years, probably due to its almost fantastical scope. However, the 'medium term' of 500 years after closure is mostly neglected in the public discourse even though many important decisions will still need to be made during this period (and during the preceding, temporally unspecified period of filling and operation of the repository), e.g. concerning criteria for potential recovery, marking of the site and knowledge transfer. Therefore, it needs to be made very clear that the issue will not end in 2031 and that the selection of the site is only one step in the overall process of final storage.

Statements about the future development of a system become possible by looking into the past. The farther one can look back and understand the developments up to the present, the farther one can predict further developments in the future. Following this approach, one is able to predict changes of the host rock for about one million years. This is possible because the geological processes that took place in these rocks have largely been understood at least for the past 250 million years of earth history. This approach cannot be directly transferred to technological developments. However, humans are capable of conceiving and producing buildings or technical systems with a long durability, so that from a technical point of view as well, we can find the best

Furthermore, since the period of one million years is established in the German Repository Site Selection Act (with similarly long-time horizons in the equivalent laws of other countries), "engaging with such radically long-term timespans is no longer just for the astrophysicists, theologians, palaeontologists, geologists, evolutionary biologists, or archaeologists among us. It has become our collective task" (Ialenti 2014, para. 10). What might be called 'time literacy' (here understood as the ability to conceive of and discuss vastly different time horizons individually and together, without losing sight of the medium term) is an important part of empowering civil society to handle this future task in a responsible way.

Therefore, one of the first challenges of communicating the future of high-level radioactive waste disposal is to find appropriate ways to actually address all time horizons of the future that are of relevance. The article will proceed, first, to discuss why it is so difficult to communicate the time horizon of 500 years after repository closure at all, and the one million years in a concrete, meaningful way. Second, suggestions for improving communication, e.g. focussing on generational approaches, will be made.

Different conceptions of time

Apart from the obvious fact that the next decade is a lot easier to conceive of than half a millennium, the difference between the A series of time (*Modalzeit* in German) and the B series of time (*Lagezeit* in German) might help to explain why it is easier to communicate about 2031 than about '500 years from x' (x being the time when the repository is closed). The distinction between A series and B series was initially proposed by McTaggart (1908). Events in the A series are ordered in terms of past, present and future; the B series orders events in terms of "earlier

https://doi.org/10.14512/tatup.31.3.18

than" or "later than". While in the A series, the present or the starting point of a time sequence is a necessary reference point, events in the B series can be located e.g. with the help of a calendar or a clock. '2031' is a designation according to the B theory of time, while '500 years from x', following the A theory, makes sense only with reference to the exact starting point, which is not yet known and thus makes the period in question more difficult to talk about with certainty. Arguably, 'one million years from an unspecified starting point' is also a designation according to the A series. However, the very unusualness of this long-time horizon is probably reason enough to talk about it.

Our scope of action concerning the long-term goal of safe disposal is located only at the very beginning of the overall period of one million years. Delays in the storage and closure phases would not change the fact that safe containment of the radioactive material will subsequently have to be guaranteed for one million years. Despite this fact (and although we think we have a relatively good overview of the early stages of disposal after site selection), it is difficult for us to deal with these periods because they relate to the A theory and their starting points are still unknown.

Our scope of action concerning the goal of safe disposal is located only at the very beginning of the overall period of one million years.

Concerning the subject of high-level radioactive waste disposal in particular, a number of other ways to distinguish between different time horizons have been proposed. For instance, the final report of the Preservation of Records, Knowledge and Memory across Generations Initiative (RK & M) distinguishes between three timeframes: "The 'short term' refers to the period of time that ends with repository closure. This period includes both the pre-operational and the operational phases of the repository. The 'medium term' refers to the period of time with oversight activities that would follow repository closure. The 'long term' refers to the period of time with no repository oversight" (RK & M Initiative 2019, p. 49). Closure and end of oversight are the decisive points in this delineation.

Another differentiation is proposed in an article on future generations in the context of high-level radioactive waste: "We define 'close future generations' as generations who still have memory of the waste and its location, and 'remote future generations' as generations who have lost its memory" (Kermisch 2016, p. 1799). Here, the line is drawn between memory and memory loss at some unspecified point in the future.

An article on the French deep geological repository project Cigéo describes the coexistence of two forms of time in separate spheres: the manageable historical time of generations above ground and the geological time of deep storage below ground (Poirot-Delpech and Raineau 2016, p. 1826). The authors suggest that the gap between these two time horizons is apparently bridged by the Observatoire pérenne de l'environnement (OPE). This permanent observatory is tasked with monitoring the environmental conditions around the storage site and preserving biological samples, which future generations may retrieve and analyse. "The OPE thus makes the environment of the future repository, that is, its 'surface world,' an extension of the underground world: it represents the continuity between the present and the future; what is transmitted from one generation to another, and thus constantly redefined" (ibid., p. 1822). This approach (and the ones discussed in the following paragraphs) might help to address the 500-year period in particular. However, even with the work of the OPE, the actors involved in Cigéo cannot picture the very long intermediate period between the transmission of information and memory about the repository from generation to generation and the containment of the nuclear waste over geological periods: "Between the two there appears to be a horizon that cannot be represented, a sort of representational blind spot" (ibid., p. 1826).

In order to empower citizens to preserve nuclear memories, Andra, the French agency for nuclear waste management, has established memory groups (*groupes mémoires*) at all sites where it currently maintains storage facilities or projects (Andra 2021, p. 11). These groups are formed by residents who – with the help of artists – consider ways to transmit the memory of the storage sites to future generations (ibid., p. 15).

In a similar way, albeit not related to nuclear waste disposal, Bjornerud (2018, p. 176) suggests that "intergenerational commons" such as oral history projects or community gardens are needed for people of all ages to gather and become aware of their intergenerational and intertemporal entanglements with other people and the world around them.

This intergenerational approach is shared by Icelandic writer Magnason who invites his daughter to imagine the time span covered by the lives of people with whom she can feel a personal emotional bond. With her great-grandmother who was born in 1924 and her own potential great-grandchild who might live until 2186, she might personally know and influence people who are alive over a period of more than 250 years (Magnason 2021, p. 22). From such an intergenerational point of view, the perspective of 500 years suddenly does not seem that long at all.

The plethora of suggested temporal differentiations, blind spots and unknown points in time discussed in this section does not make the situation any easier, but it can perhaps serve as an invitation to think about time horizons of nuclear waste disposal in a more encompassing and creative way. Incorporating the appreciation of such different conceptions and delineations of time (and the various tasks that have to be addressed at the different stages) into communication efforts might help to im-

 https://doi.org/10.14512/tatup.31.3.18

prove the public's awareness and understanding of the relevant time horizons of high-level radioactive waste disposal and the important choices one can still get involved in once a site has been found and a facility has been built.

Considering the future

Another interesting aspect is that thinking and writing about the future as a sphere that can be influenced by humans is a relatively recent concept. The initial way of talking about future events considered them as something that would happen to people regardless of their own choices. The future was seen as something that comes towards people. However, at the turn from the 17th to the 18th century, a new way of addressing the future developed. In this modern conception, it is the human being who moves through time and can actively shape the empty space of the future (Hölscher 2016, p. 42). Given this relatively recent change in our consideration of the future, it is perhaps not surprising that we struggle particularly to conceive of the far future and our potential role in it.

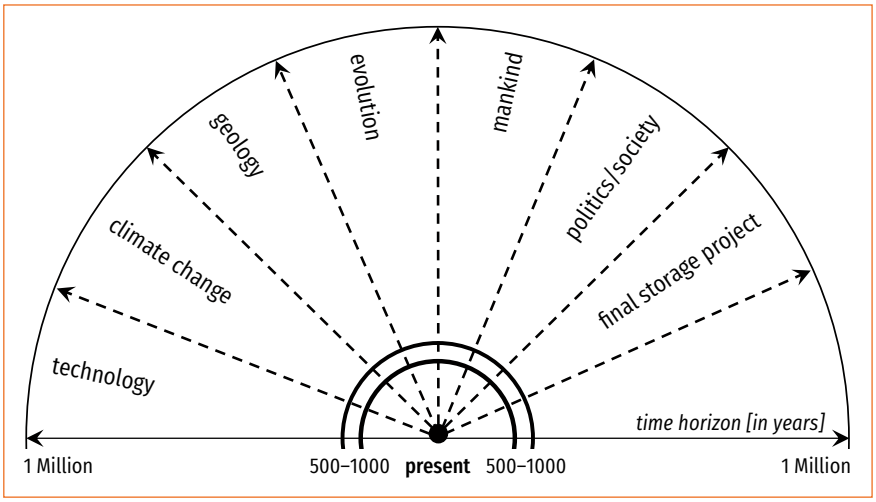


Fig. 1: Potential divergence of thematic strands from each other on the path to the future.
Source: authors' own compilation

Furthermore, it must be noted that people normally think into the future within a limited topic (e.g. climate, technology or final storage) and do not incorporate many contingencies. Issues outside the respective area of consideration are usually excluded as improbable or not mentioned at all. For the discussion in the ongoing site selection process and the legal stipulations on the scope of final disposal (up to one million years), a certain stability of other thematic strands is therefore assumed. In order not to pull the rug out from under the feet of the future planning of final disposal, the social or political development (even though it may include drastic changes) must remain constant as a basic prerequisite to develop one's own thematic strand. However, the farther we think and plan into the future, the more drastically divergent the thematic strands can become. This is illustrated in Figure 1, and it can be deduced that it seems safer to focus on shorter periods of time in the overall system in order to maintain a realistic chance of success through the still-existing proximity of the thematic strands.

Inspiration from other scientific disciplines and artistic approaches to time

In any case, one million years seems far removed from the years and decades of an individual human life or the centuries, maybe millennia of human societies. Even thinking hundreds of years into the future is unusual for political sciences, legal studies or engineering. However, for other disciplines, such as evolutionary biology, palaeontology or geology, considerations of thousands, millions or even billions of years are tools of the trade. Looking at the way geology in particular understands and represents time might provide some valuable insights for the communication of the time horizons of high-level radioactive waste disposal.

Geologist Marcia Bjornerud (2018, p. 163) describes her polytemporal way of looking at her surroundings: "I often feel I live not just in Wisconsin but in many Wisconsins. Even when I try not to, I can't help but sense the lingering influence of the many natural and human histories embedded in this landscape: the forests still recovering from nineteenth-century clear-cutting […]; contorted gneisses that are the surviving roots of Proterozoic mountains. The Ordovician is not a dim abstraction; I was there with students just the other day!" (The Proterozoic is a geological eon spanning the interval from 2.5 billion years to 541 million years ago, the Ordovician is a geological epoch lasting from 508 to 440 million years ago (ibid., p. 184)).

Another way to conceive the depth of time is through the collaboration of science and art. For instance, Hamburger Kunsthalle hosted an exhibition called 'Futura' in spring 2022. One exhibit, 'Perpetuum Mobile' by Nina Canell, showed a sack of cement next to a water basin agitated by ultrasonic waves. The water vapour from the basin caused the cement to harden slowly. According to the museum information, this display is supposed to trigger thinking about the irreversibility of certain processes. This installation resonated strongly with the topic of high-level radioactive waste disposal for two reasons. First, cement (as concrete) is one of the materials employed in the storage process of radioactive waste, and second, high-level radioactive waste is – at present – not fully recyclable (since only some of the materials involved can be reused and transmutation has not yet been successfully developed).

https://doi.org/10.14512/tatup.31.3.18

In 2014, the US National Academy of Sciences dedicated an exhibition to the visualization of geological deep time (the depth of geological time compared to historical time). 15 artists were invited to consider the role art might play in comprehending such vast time horizons, which are way beyond the experience of individual humans and *Homo sapiens* as a species. The organizers suggested that "[u]nderstanding deep time lies, perhaps, in a combination of the rational and the intuitive" (Talasek 2014, p. 7).

In another attempt to grapple with deep time, artist Rachel Sussman has been researching and photographing living organisms older than 2,000 years, such as brain corals in the Caribbean or actinobacteria from Siberian soil samples which are at least 600,000 years old (Sussman 2014). These examples show that deep time is not only the domain of inanimate rocks but that certain living organisms might help to bridge the gap between historical time and geological time.

Another creative way of representing geological time is employed by the DeepTime Walk app (Deep Time Walk C.I.C. 2022). This app accompanies users on a 4.5 km walk through the history of the earth in a location of their choice (one metre equates to one million years) with an audio file combining scientific information and a poetic approach. Starting 4.5 billion years ago, what this Deep Time Walk makes particularly clear is the extent of time during which not very much happened, while events follow in quick succession during the last 500 metres. A similar approach is taken by representations of the history of the earth on a twelve-hour clock face. If twelve hours represent the 4.5 billion years of earth history, one second on the clock corresponds to 104,167 years and *Homo sapiens* has only been around for about three seconds (Brightmore 2022).

Instead of looking at the past, the rationale of the Deep Time Walk app and the clock face can also be used to look into the future of high-level radioactive waste disposal. Figure 2 shows a twelve-hour clock face in relation to the legal safety requirement of one million years. The figure makes very clear that our scope of action referring to the long-term goal is located only at the very beginning of the period. Even under conservative assumptions, e.g. through delays in the start of storage or in the closure phase, and with the addition of the 500-year recoverability period, we will not get beyond the first minute.

Conclusion: looking towards the future of high-level radioactive waste disposal

In the course of this article, we discussed two challenges for communicating the future of high-level radioactive waste disposal: incorporating the time horizon of 500 years after repository closure and representing one million years in a more meaningful way. For the first challenge, a number of solutions have been proposed or are already under way. Many of these suggestions focus on the transmission of knowledge from one generation to another, be it through the establishment of memory groups and the work of the OPE in France, Bjornerud's intergenerational commons or Magnason's thought-experiment. Concerning the second challenge, conceptualising one million years is likely to require creativity and leaps of imagination. Ultimately, Talasek's (2014, p. 7) proposition to combine "the rational and the intuitive" and the use of more creative visualizations might be a good place to start.

However, as long as people are not aware of the different conceptions and delineations of the time horizons involved in nuclear waste disposal, switches between them (which take place all the time and often unconsciously) can easily produce misunderstandings. 'Time literacy' is therefore essential to help people make meaningful decisions about the future.

By being aware that our genus *Homo* has only been present in the last 2.8 million years and that global climate changes were significant drivers of our evolution, the envisaged one million years of safety can be put into perspective with regard to their direct relevance for our actions today. Through the discovery of physical half-life, we have found a measure that enables us to calculate when the radioactive waste can be considered uncritical for humans in terms of its radiation. This led to the stipulation that the nuclear waste should remain isolated from the biosphere for one million years. Based on the laws of nature, this is a good way to justify the need for long-term final disposal of high-level radioactive waste.

Since we humans must subordinate ourselves to the laws of nature, without

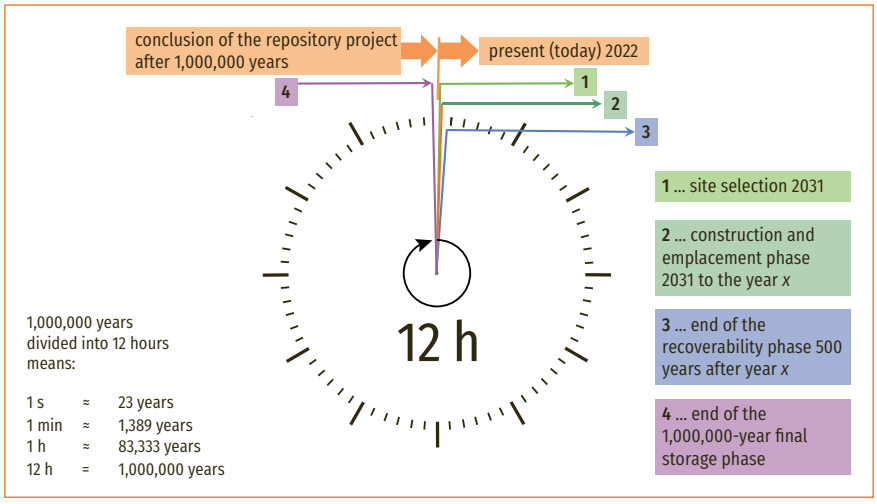


Fig. 2: Transfer of the time horizons of high-level radioactive waste disposal to a period of 12 hours.
Source: authors' own compilation

https://doi.org/10.14512/tatup.31.3.18

representing one ourselves, it is not possible to make valid predictions for events that lie so far in the future, because we often behave arbitrarily and unpredictably even in the near future. Assuming that through delays and complications, the repository might only be closed 150 years from now, the 500-year recoverability phase would extend to 650 years from now. Insofar as one could speak of stability at all, and insofar as these periods until repository closure and the end of the recoverability phase of a repository in Germany could function as a stable phase of human society, we should concentrate (in implementation and communication) on this medium term of nuclear waste disposal. We must then trust that the generations living at that time will be able to live with what we have left behind based on the best possible considerations.

Successful outcomes are likely achieved by proceeding step by step without being blinded or disillusioned by the far-away horizon of one million years or the fast-approaching year 2031. The main task – and already enough of a challenge – is therefore to plan and manage the next 650 years of high-level radioactive waste disposal in an appropriate way. After that point, the manageable historical time of generations can slowly be allowed to phase out into the geological time of deep storage, even though conceptually and imaginatively, it might never be possible to fully bridge the gap between these two time horizons.

Funding • This article has received funding by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) as part of the authors' work in the collaborative project TRANSENS (project no. 02E11849A-J).

Competing interests • The authors declare no competing interests.

References

Andra – Agence nationale pour la gestion des déchets radioactifs (2021): Le Journal de l'Andra 38. Available online at https://www.andra.fr/sites/default/files/2021-03/Andra%20Journal%20%2338_Manche_BDweb.pdf, last accessed on 14. 10. 2022.

BGE – Bundesgesellschaft für Endlagerung (2020): Zwischenbericht Teilgebiete gemäß § 13 StandAG. Peine: Bundesgesellschaft für Endlagerung mbH. Available online at https://www.bge.de/fileadmin/user_upload/Standortsuche/Wesentliche_Unterlagen/Zwischenbericht_Teilgebiete/Zwischenbericht_Teilgebiete_barrierefrei.pdf, last accessed on 17. 10. 2022.

Bjornerud, Marcia (2018): Timefulness. How thinking like a geologist can help save the world. Princeton, NJ: Princeton University Press. https://doi.org/10.2307/j.ctvc772cs

Brightmore, Jamie (2022): Deep time. A history of the earth – interactive infographic. s.l.: Jaybee Productions. Available online at https://deeptime.info/, last accessed on 17. 10. 2022.

Deep Time Walk C. I. C. (2022): Deep Time Walk app. Walk a history of our living Earth. Available online at https://www.deeptimewalk.org/kit/app/, last accessed on 14. 10. 2022.

Geiger, Boris (2021): 42 – Die Antwort auf fast alles. Wie lösen wir das Atommüllrätsel? Strasbourg: ARTE GEIE. Available online at https://www.arte.tv/de/videos/101940-003-A/wie-loesen-wir-das-atommuellraetsel/, last accessed on 15. 09. 2022.

Hölscher, Lucian (2016): Die Entdeckung der Zukunft. Göttingen: Wallstein.

Ialenti, Vincent (2014): Embracing 'Deep Time' thinking. In: 13.7 Cosmos & Culture Commentary On Science And Society. Available online at https://www.npr.org/sections/13.7/2014/09/28/351692717/embracing-deep-time-thinking?t=1611840682946, last accessed on 14. 10. 2022.

Kermisch, Celine (2016): Specifying the concept of future generations for addressing issues related to high-level radioactive waste. In: Science and Engineering Ethics 22 (6), pp. 1797–1811. https://doi.org/10.1007/s11948-015-9741-2

Magnason, Andri (2021): Wasser und Zeit. Eine Geschichte unserer Zukunft. Berlin: Insel.

McTaggart, John (1908): The unreality of time. In: Mind 17 (4), pp. 457–474. https://doi.org/10.1093/mind/XVII.4.457

Poirot-Delpech, Sophie; Raineau, Laurence (2016): Nuclear waste facing the test of time. The case of the French deep geological repository project. In: Science and Engineering Ethics 22 (6), pp. 1813–1830. https://doi.org/10.1007/s11948-015-9739-9

RK & M Initiative (2019): Preservation of records, knowledge and memory (RK & M) across generations. Final report of the RK & M initiative. Boulogne-Billancourt: OECD – Nuclear Energy Agency. Available online at https://www.oecd-nea.org/upload/docs/application/pdf/2019-12/7421-rkm-final.pdf, last accessed on 14. 10. 2022.

Sussman, Rachel (2014): The oldest living things in the world. Chicago, IL: University of Chicago Press. https://doi.org/10.7208/chicago/9780226057644.001.0001

Talasek, John (2014): Imagining deep time. Exhibition catalogue. Washington, DC: National Academy of Sciences. Available online at http://www.cpnas.org/exhibitions/imagining-deep-time-catalogue.pdf, last accessed on 14. 10. 2022.

Wollenteit, Ulrich (2019): Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle (Standortauswahlgesetz – StandAG). In: Walter Frenz (ed.): Atomrecht. Atomgesetz und Ausstiegsgesetze. Baden-Baden: Nomos, pp. 443–594.

MARGARITA BERG
is a biologist who has worked in various projects at the chair of Philosophy and Ethics of the Environment of Kiel University since 2013. She has worked in the TRANSENS project on nuclear waste disposal in Germany since 2020, focussing mainly on different aspects of communication.

DR. THOMAS HASSEL
studied materials science at the University of Erlangen-Nuremberg. He received his doctorate in 2008 at the Institute of Materials Science at Leibniz University Hanover. Starting with research on the dismantling of nuclear facilities, he has been working since 2013 on technical topics of final storage of highly active, heat-generating waste materials.

https://doi.org/10.14512/tatup.31.3.18

RESEARCH ARTICLE

No time to waste: Exploring timeprints of radioactive waste management options in Belgium

Sacha Frenay[1], Céline Parotte*,[1]

Abstract • Following the work of Barbara Adam (1998) and Ulrike Felt (2016), we draw particular attention to 'timeprints' in the assessment and selection of radioactive waste management (RWM) options. Using the example of Belgium, we identify four different timeprints mobilized (un)consciously by stakeholders when assessing RWM options, namely trajectorism, promise economy, radioactive waste identity, and multi-situated timeprints. We show that each of these timeprints has a significant impact on the RWM option to be considered and actively determines future radioactive waste management pathways in the form of 'tacit governance'.

***Keine Zeit zu verlieren**: Untersuchung von ‚timeprints' für die Entsorgung radioaktiver Abfälle in Belgien*

Zusammenfassung • *In Anlehnung an die Arbeiten von Barbara Adam (1998) und Ulrike Felt (2016) legen wir besonderes Augenmerk auf die zeitlichen Abläufe bei der Bewertung und Auswahl von Optionen für die Entsorgung radioaktiver Abfälle (radioactive waste management – RWM). Anhand des Beispiels Belgien identifizieren wir vier verschiedene ‚timeprints', die von den Interessenvertretern bei der Bewertung von RWM-Optionen (un)bewusst eingesetzt werden, nämlich ‚trajectorism', wirtschaftliche Versprechen, Identität radioaktiver Abfälle und ‚multi-situated timeprints'. Wir zeigen auf, dass jede dieser ‚timeprints' einen wesentlichen Einfluss auf die in Betracht zu ziehenden RWM-Optionen hat und die zukünftigen Entsorgungswege für solche Abfälle in Form einer ‚tacit governance' aktiv mitbestimmt.*

* *Corresponding author: celine.parotte@uliege.be*
[1] *Spiral Research Center, University of Liège, Liège, BE*

https://doi.org/10.14512/tatup.31.3.24
Recieved: Jun. 02, 2022; revised version accepted: Oct. 21, 2022;
published online: Dec. 16, 2022 (peer review)

Keywords • *timeprints, politics of time, tacit governance, radioactive waste management options, Belgium*

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler. https://doi.org/10.14512/tatup.31.3.10*

Introduction

Time orders human actions and decisions, and is strongly entangled with questions of knowledge and control (Felt 2016). Deeply embedded in individual and collective narratives that give "feelings of stability and belonging" (Felt 2016, p. 2), time is not a straightforward physical entity. It is constructed and reflects clashes and wins that have concrete consequences for both the world we live and wish to live in. Yet, the politics of time is "all-too-easily naturalized and turned in the deep structure of taken-for-granted, unquestioned assumptions" (Felt 2016 b, p. 2).

By bringing time to the forefront of radioactive waste management (RWM) assessment and selection in Belgium, the purpose of this article is twofold. First, based on key analytical assumptions (Adam 1998; Felt 2016), it aims to highlight the framing power of time in RWM. We suggest this can help to understand the lock-in and alternatives of future RWM programs, by highlighting how temporal prints (called 'timeprints') inform the scope and impact of our current choices and designs through time. This paper is an invitation to explore RWM timeprints in different nuclear contexts. The Belgian case aims to pave the way, and, together with the political decision on high-level waste (HLW) management that has been pending for decades, it allows for a broader perspective to examine all RWM options and the potential timeprints they create, without framing the debate exclusively on the nuclear community's preferred option (geological disposal).

Concretely, we ask two questions: (1) How do geological disposal and alternative RWM options carry on and engage a particular temporal regime? (2) How do these competing temporal regimes order RWM? We rely on data collected during two rounds of online structured questionnaire submitted to 580 pre-selected Belgian stakeholders in 2019 (Parotte and Fallon 2020)[1]. We asked them to compare eight RWM options that were still being debated: geological disposal, eternal surface storage, eternal subsurface storage, storage on the site where the waste is produced, storage on the site where some waste is already temporarily stored, storage on a site to be determined, advanced nuclear technologies such as transmutation, and waiting for future generations to find a better solution (ibid., p. 13). We analyzed the implicit and explicit temporal narratives in the reasoning of Belgian respondents by adopting an interpretivist position.

In what follows, section 1 details the conceptual tools and the current state of RWM in Belgium. Section 2 describes the four identified Belgian RWM timeprints in order to highlight how each responds to its own motivations, which significantly change the option(s) to be considered. In the discussion section, we stress that every timeprint actively performs the future pathway(s) to manage HLW as a form of 'tacit governance' (Felt and Fochler 2010), understood as an implicit form of pathway orientation that performs institutions and individuals' reactivity (Espeland and Sauder 2007). We highlight the uneven consequences and conflicts between those RWM timeprints and suggest how they could potentially (re)order the RWM program. We conclude that identifying timeprints of the chosen RWM option (geological disposal or any other alternative) in each management program and considering its consequences could be an element in understanding the implementation (in)actions and their justifications.

Material and methods

To assess the temporal regime of RWM options, we mobilize three theoretical concepts: timescapes, living futures, and timeprints. Each insists on particular issues concerning the politics of time (Felt 2016), namely the situated nature of time, the relative linear sequence of time, and the persistent prints that time produces.

First, decrypting the framing power of time involves analyzing time in its relations with a particular sociotechnical environment. Barbara Adam (1998) combines 'time' with 'scape' to stress the intertwined character of multiple coexisting forms of time and their embodiment in a specific and unique context. In short, the concept of 'timescapes' fights against the universal idea of time to point out the existence of constant and situated 'temporal inconsistencies' – the challenges and tensions resulting from this simultaneous presence of different forms of time (Felt 2016 b).

To assess the temporal regime of radioactive waste management options, we mobilize three theoretical concepts: timescapes, living futures, and timeprints.

Second, Adam and Groves (2007) introduced the concept of 'living future', understood as neither predetermined nor indeterminate but embedded in everyday knowledge practices, to question the linear sequence past – present – future of a timeline. Every action contends 'a not-yet future' and an 'already there'. In this sense, time periods are strongly entangled and fictively sequenced. If the 'not yet' seems to be inaccessible to matter of facts, futures are still currently 'lived' (Adam and Groves 2007).

Finally, every action we take leaves particular prints. Adam and Groves (2007) also proposed the term 'timeprint' to question how far the impact of our present way of life extends space and matter across time. Particular knowledge practices can lead to consumption or appropriation of successors' futures (Adam and Groves 2007): future-making inevitably involves future-taking.

A responsible and ethical approach to the future implies taking this interconnection into account – our actions and their effects extend into the future present of subsequent generations – rather than acting solely from a present future perspective (Adam 2010).

With the illustrative 'temporal landscape' we have chosen, Belgium in 2019, the following sections explain how the study of 'timeprints' highlights contrasting 'living futures'. Belgium has a long history of nuclear power (beginning in the 1920s with the exploitation of uranium mines in Katanga) and with seven pressurized water reactors, the country remains highly dependent on nuclear energy production (49.7 % in 2021). Belgium deals with a relatively large amount of radioactive waste. For low-level waste (LLW), the surface disposal option was validated by the Federal government in 2006 after a participatory process launched in 1998. The long-term management strategy for HLW remains the main challenge, although the National Research Center for Nuclear Energy formally launched the preliminary research and development program on geological dis-

1 This paper focuses on a particular sample of the data collected during the Delphi survey (i.e., the responses to the questions comparing eight RWM options) to which we apply a different theoretical framework. For a full overview of the scientific report, see Parotte and Fallon (2020).

https://doi.org/10.14512/tatup.31.3.24

posal in 1974 and built an underground laboratory in 1980 to study this option. Two rounds of national public consultations (in 2009–2010 and in 2020) were organized to discuss the HLW program. Both the long-term waste manager (ONDRAF) and the regulatory body agency (AFCN) acknowledge geological disposal as the reference option, but public consultations and some environmental associations regularly emphasize the need for open debates on RWM (e.g. on options, framing, and the participatory process). Since 2011, successive federal governments have delayed the adoption of national program for HLW until very recently. In April 2022, the Federal Government agreed to pursue R & D activities for deep disposal in Belgium, to explore developing shared disposal facilities with interested countries, and to organize a public debate (Council of Ministers 2022).

Most Belgian stakeholders consider a promising radioactive waste management option to be 'feasible' given a predictable and manageable time horizon.

The data on which this article is based were collected in a Delphi survey that ran from April to November 2019, in a context of no political decision on a HLW program. Here, we exclusively focus on the sample responses of Belgian stakeholders relating to the comparison of eight plausible RWM options (n = 193)[2]. By following the temporal narratives (European Commission 2007) – a tacit way of sharing meaning and constituting a broader sense of direction (making and taking the future) – mobilised by Belgian respondents to compare radioactive waste management options, we identify four timeprints.

Four RWM timeprints in Belgium

Trajectorism

'Trajectorism' narrates an alignment of past, present, and future in a single pathway through which progress and economic success are collectively conceived as achievable (Felt 2016). This timeprint is particularly mobilized to assess geological disposal and future advanced nuclear technology options (e.g. transmutation), two main RWM options that have been studied for decades by the Belgian nuclear scientific communities. More than half of the respondents consider that the option of geological disposal is worth considering. While few justify why, the accumulation of scientific knowledge and the maturity of the option seem important. Respondents argued, for instance, that geological disposal is the *'most realistic' and 'appropriate'* considering knowledge accumulation, *'the only long-term solution'* which is *'permanent'*, and the *'only immediately operational final solution'*. In the more distant future, most of them plan to invest in advanced nuclear technologies. The generation of (future) scientific knowledge also seems to be an essential justification for providing *'newer and better technologies like transmutation'* that *'will provide solutions that do not exist today'*, or that *'will eventually be an alternative to geological disposal, which must be accepted until then'*.

Conversely, other respondents implicitly reject trajectorism, considering that the arguments listed above are not sufficient. They combine RWM options to keep all options open as *'for now, no option offers sufficient safeguard'* or at least they consider them as *'not mutually exclusive'*. For instance, geological disposal and transmutation may be combined due to residual waste; surface or on-site storage *'keeps options open for new technologies'* and are *'temporary solutions before geological disposal is operational in optimal conditions.'*

Both geological disposal and advanced nuclear technologies tacitly support the idea of a 'linear innovation trajectory' (Felt 2016 b), assuming that there is a cumulative path from here to there, specifically from now to tomorrow (Appadurai 2012). Envisioning one (or two) steadily unfolding direction of change, this timeprint relies on a predictable and calculable future through the projection of stabilized and upcoming knowledge (Adam 2010). It already conceives the scientific and economic living futures of RWM options, and how to debate them. For instance, without strongly supporting geological disposal, some stakeholders present it as *'a default choice'*. Trajectorism is driven by a logic of increasing returns (Arthur 1994) and the imperative to remain economically competitive: It affects what most funding is spent on, how research will (not) engage in innovation projects and closes down alternative innovation pathways (Felt 2016). Most Belgian stakeholders are aware of the closing down and monotonic process of this timeprint, and sometimes resist it by refusing the singularity of one particular RWM option.

Promise economy

This timeprint focuses on how (and what) emerging technologies can be seen as promising solutions to RW problems. Such promises work as a speculative bubble (Beckert 2016): despite the future's inescapable uncertainty, their narratives must instill confidence to create a performative fiction that attracts financial, political, and technical resources (European Commission 2007).

2 As the questionnaire was completed anonymously, quotes from respondents will not be referenced but in italics and between inverted commas.

https://doi.org/10.14512/tatup.31.3.24

Hence, most Belgian stakeholders consider a promising RWM option to be *'feasible'* given a predictable and manageable time horizon. Again, geological disposal remains a relevant option in a short temporal frame: *'The problem of any alternative to geological disposal is its lengthy development time.'* In this sense, 'trajectorism' and 'promise economy' are mutually reinforcing, as promises foster a state of necessity and urgency that oppose the freedom to imagine multiple future pathways (Joly 2015). The shared multinational RWM option, which several stakeholders are combining with the geological disposal option, seems to be considered a *'highly desirable'* promise, while acknowledging that it is still in the conditional stage.

Respondents did not mention eternal surface storage or on-site storage options as a promise economy timeprint, but they are clearly divided on the promising option of transmutation. Some of them consider transmutation as a *'serious alternative to geological disposal'* to reduce the lifespan of HLW or to serve as an *'intermediate stage'* before future generations find an *'even better solution'*. The others are not convinced of its *'real added value'* for contrasting reasons that lead to other past and current pathways. One group considers transmutation to be a *'utopia'* that is not mature enough and *'too costly to be implemented as a mass technology'*. Instead, this group suggests reconsidering the reprocessing option legally abandoned in 1993 in Belgium. Another group explicitly refuses 'promise economy', either by arguing that *'we cannot continue to use possible future technological developments as an excuse to delay the decision'* or by considering them as a deferral of responsibility. As they deem that *'no option is convincing for now'*, surface and on-site storage investment should be *'the priority […] set on improving the safety of the option used now as a temporary solution'*.

This timeprint leads to contrasting imaginaries of technological progress: a progressive one based on an optimistic consideration of the role of technology in the future (in favor of different RWM options such as shared geological disposal, transmutation, and reprocessing) versus a precautionary view highlighting a more skeptical position.

Radioactive waste identity

This timeprint explores how the different ways of naming a radioactive object affect which RWM options are preferred in the future. Some respondents emphasize that a distinction should be made between waste, which is considered as *'not retrievable'*, and spent fuel, which may offer *'potential energy resources.'* Others expect that the identity of the radioactive object may change over time, for example when future innovations and knowledge could turn *'old waste into a resource.'*

With regard to the transmutation option, some stakeholders specify that it is potentially a relevant option for future waste but that it *'does not constitute a solution for current vitrified waste'*. What about the final waste that will always remain? They sustain that the leftovers not included in the current classification will influence what to consider *'as a solution in itself.'* For still others, on-site storage and subsurface storage options offer the *'important advantage'* of ensuring easy retrievability of the waste and its future use. Stakeholders in favor of geological disposal face similar debates: some consider *'passive disposal'* as a prerequisite for geological disposal, which closes the debate on the identity of the radioactive object; others argue that it would be *'fair to let future generations judge the attractiveness of waste'*. Besides, the plural identities of radioactive objects in different countries call into question the operationalization of a multinational RWM option. One respondent reminds us that, for the time being, *'there is a diversity of waste to manage but a uniqueness of storage.'*

RWM options are redefined through both temporal and competing imaginaries, as the identity of the radioactive object requires fundamentally opposing strategies in different timescapes: It can be considered either as a resource (actual or potential) that is stored before being reused, or as a byproduct that must be permanently disposed of.

Multi-situated

The multi-situated timeprint addresses the mobility of RWM options and how temporal narratives relate to different sites.

Most Belgian stakeholders strongly support the possibility of a shared multinational option, which is seen as *'technically desirable'* and as a *'potential game changer'* capable of reaching beyond the country's official borders. Some argue that it is particularly relevant for small countries: *'It is irrational to imagine a country the size of Belgium or Luxembourg developing its own program for small waste quantities.'* But for many, it is also a *'utopia'* because of the ethical and legal challenges, such as the waste ownership and responsibility through time, cost sharing between countries and generations, different political and cultural sensitivities, and waste and regulatory management systems. They raise additional concerns about risks and unfair host site selection.

The situatedness (or lack thereof) is a concern for all other RWM options, but is not regularly mentioned. For instance, stakeholders did not distinguish between on-site storage options but expressed concerns about the safety and site exposure (e.g. radiation and external threats) associated with any *of* the on-site, eternal surface storage, and subsurface storage options.

Options are presented as detached from sites, even if any innovation trajectory develops out of a complex entanglement of situated histories (Felt 2016b). They are narrated as generic despite the very situated character of the timeprint.

Discussion

This paper highlighted the RWM timeprints in a particular timescape in Belgium in 2019, and the contrasting living futures in Belgian stakeholders' narratives of long term RWM. Stakeholders mobilize implicit and explicit temporal narratives to justify actions or favor one particular solution.

https://doi.org/10.14512/tatup.31.3.24

Ordering, clashes, and silences of RWM timeprints in Belgium

In this first part of the discussion, we summarize our findings on the Belgian case and underline that a hierarchy is produced among RWM options. Our results support the first of Felt's (2016) arguments about the 'politics of time': The four identified timeprints tacitly order the RWM pathways by reinforcing some and overlooking others. With 'trajectorism', both scientific and economical 'living futures' of RWM options encourage funding for geological disposal and advanced nuclear technologies. The accumulation and promise of scientific knowledge are a central rationale for the future of RWM and are primarily aligned with past and current Belgian R & D projects. Interestingly, Belgian stakeholders (even if they were not all scientists) have assimilated that geological disposal has been presented as the only option (even as a default choice). The 'promise economy' timeprint, strongly associated with a manageable time frame, reinforces an alignment of past, current, and future knowledge to also support the already funded options: geological disposal and transmutation. The radioactive waste identity timeprint emphasizes that today's waste could be tomorrow's resource and that these current uncertainties are mobilized to revive past options (e.g. reprocessing), to avoid more challenging options (e.g. shared multinational option), or to provide retrievability components to any RWM option. Finally, the multi-situated timeprint emphasizes how situatedness (or lack thereof) both supports arguments to justify and challenge a shared multinational solution (primarily associated with the geological disposal option) while it is (un)consciously kept out of the way of current on-site options and alternatives.

Our analysis confirms the second of Felt's statements (2016b): the politics of time is about clashes, inconsistencies, and silences. Aware of the uneven consideration of RWM options, some stakeholders argue, explicitly or tacitly, for control over the framing power of timeprint, and several alternative temporal narratives are proposed. Options should be combined rather than seen as mutually exclusive (e.g. transmutation should be seen as complementary to geological disposal). Improving current surface and on-site storage should be explored, even as a temporary solution before other options are sufficiently mature. The retrievability element of the RWM option should be considered as the primary criterion for eternal storage or as an additional element for geological disposal. Even options presented as 'utopian' (e.g. shared multinational or not-yet-existing technological RWM options) are brought to the fore. We interpret these attempts as a *re*-action to the tacit governance that sustains the two well-known RWM options explored for decades in Belgium: geological disposal and the transmutation option.

Last, we believe that absence of data – the silences – is an outcome in itself. We emphasize how situatedness remains secondary in the RWM timescapes: The (future) multi-situated character of any option is mostly kept out of stakeholder discourses. It is interesting to note how stakeholders silence the operational temporalities – "a nexus of political-economic forces, scheduling and regulatory pressures" (Ialenti 2021, p. 3) – related to current on-site options. The so-called 'temporary' on-site storage options are the most permanent RWM option already built, on distributed sites of nuclearized countries. Similarly, favoring the shared multinational option can be interpreted as another silence to avoid the 'scape' of our nuclear timescapes. Managing our situated waste (where it is produced) to other sites disentangles time and scape.

How to maintain the responsible entanglement of our waste? And how to ensure the reliability of any political organization over such a long-term horizon?

Choreography of RWM timeprints

This second part of the discussion extends the reflection beyond our empirical findings and discusses how this hierarchy among RWM pathways might be challenged in the future. We draw on what Felt (2016b) called 'choreography' of RWM timeprints: they are connected, overlapping, and intersecting. While every timeprint defines engagement in the RWM program and the preferred option(s) differently, they collectively shape it at the same time with uneven connections. This has implications for RWM programs, and for how accountability is addressed.

In our case, the prevalence and combination of temporal timeprints (trajectorism with promise economy) create grooves so deep that they are difficult to break out of. Strongly linked with a vision of 'manageable time for operationalization', these associations of time components mark the 'living future' in an indelible way. RWM alternatives have little space to be considered at present. Thus, it prevents disruptive innovation from occurring, it silences other ways of thinking, and it imposes thinking *with* and *for* the option of geological disposal. It can support the illusion that no further public debate is needed once a technological path is chosen, that 'matters of facts' are apolitical and latent, and thus also matter when it comes to issues of responsibility (Felt 2016b).

However, we argue that some timeprints could potentially change the game in RWM program and stress the need to test this framework in different nuclear contexts. Indeed, we speculate that the identification of timeprints could prove to be a key

 https://doi.org/10.14512/tatup.31.3.24

issue in RWM for several countries. First, in countries where waste and spent fuel can still be considered a resource, the identity of radioactive waste coupled with 'promise economy' can produce contrasted living futures: with or without reprocessing (opens up the debate for nuclear energy futures) and with or without retrievability (under what conditions?). Fixing all radioactive objects in waste category organizes the right to forget or to remember and engages a clear "system of *rendez-vous* into legislation; a mutual engagement in time towards the 'fair, accurate and efficient' distribution of financial responsibilities" (Saraç-Lesavre 2020, p. 443). Second, the shared multinational option has attracted more attention in recent years. Indeed, whether to reduce costs, to share knowledge, or to cope with spatial and geological constraints, several countries are willing to jointly explore this option. Eight RW operators (of which Belgium is not part) have recently institutionalized their collaboration in the European Repository Development Organization.

Combined with the trajectorism timeprint, the multi-situated timeprint challenges the 'where' question of RWM programs and reminds us that even a shared multinational option always concentrates RW somewhere. On an ethical level, we can also see it as a way of thinking about our waste located elsewhere: Once the object is removed, the time of the waste can be evacuated. However, negotiations to organize waste mobility will be another challenge. Specifically, how to maintain the responsible entanglement of our waste, how to ensure the reliability of any political organization over such a long-term horizon, and how to cope with emerging geopolitical disorders and with national dissolutions. Being highly dependent on the relationship between countries and its evolution, this challenge raises an important question about the ability of sharing timeprint to invent a collective and legitimate tradition capable of linking multinational pasts and futures.

Conclusion

There is no time to waste. Time, especially in RWM, remains "an invisible infrastructure" (Felt 2016, p. 3) that can no longer be set aside for analysis of RWM options, programs, and actions. Exploring temporal narratives, the produced timeprints and their consequences on RWM program is one way to begin. From our analysis, we draw four systematic questions to assess the framing power of time on any national RWM program: (1) What are the temporal narratives behind the RWM option selected in your country? (2) What kind of timeprints are produced with the selection and implementation of RWM option? (3) Are these RW timeprints mutually exclusive or mutually reinforcing or weakening? (4) What timeprints do we share with other nuclearized countries and how does it open up or close down RWM futures?

The analysis of the framing power of time acts reminds us that our current (non)-actions on RWM are built on a situated temporal and sociotechnical legacy, while generating latent living futures and condemning others. Consideration of the politics of time and the entangled timeprints of RWM options may nuance the nuclear community's common assumption that geological disposal is the only long-term solution because 'there is no alternative'.

Funding • This work was supported by Fonds De La Recherche Scientifique – FNRS. The Data Collection received external funding from ONDRAF/NIRAS (2018–2019).

Competing interests • The authors declare no competing interests.

References

Adam, Barbara (2010): History of the future. Paradoxes and challenges. In: Rethinking History Routledge, 14 (3), pp. 361–378. https://doi.org/10.1080/13642529.2010.482790

Adam, Barbara (1998): Timescapes of modernity. The environment and invisible hazards. London: Routledge.

Adam, Barbara; Groves, Chris (2007): Future matters. Action, knowledge, ethics. Leiden: Brill. https://doi.org/10.1163/ej.9789004161771.i-218

Appadurai, Arjun (2012): Thinking beyond trajectorism. In: Michael Heinlein, Cordula Kropp, Judith Neumer, Angelika Poferl and Regina Römhild (eds.): Futures of modernity. Challenges for cosmopolitical thought and practice. Bielefeld: Transcript, pp. 25–32. https://doi.org/10.1515/transcript.9783839420768.25

Arthur, Brian (1994): Increasing returns and path dependence in the economy. Ann Arbor: University of Michigan Press. https://doi.org/10.3998/mpub.10029

Beckert, Jens (2016): Imagined futures. Fictional expectations and capitalist dynamics. Harvard: Harvard University Press. https://doi.org/10.4159/9780674545878

Council of Ministers (2022). Mesure politique nationale pour la gestion à long terme des déchets hautement radioactifs et/ou à vie longue. In: news.belgium, 01. 04. 2022. Available online at https://news.belgium.be/fr/mesure-politique-nationale-pour-la-gestion-long-terme-des-dechets-hautement-radioactifs-etou-vie, last accessed on 09. 11. 2022.

Espeland, Wendy; Sauder, Michael (2007): Rankings and reactivity. How public measures recreate social worlds. In: American Journal of Sociology 113 (1), pp. 1–40. https://doi.org/10.1086/517897

European Commission (2007): Taking European knowledge society seriously. Report of the expert group on science and governance to the science, economy and society directorate, directorate-general for research, European Commission. Luxembourg: Office for Official Publications of the European Communities. Available online at https://sts.univie.ac.at/fileadmin/user_upload/i_sts/Ueber_uns/pdfs_Felt/taking_european_knowledge_society_seriously.pdf, last accessed on 31. 10. 2022.

Felt, Ulrike (2016 a): Of timescapes and knowledge scapes. Re-timing research and higher education. In: Peter Scott, Jim Gallacher and Gareth Parry (eds.): New languages and landscapes of higher education. Oxford: Oxford University Press, pp. 129–148.

Felt, Ulrike (2016 b): The temporal choreographies of participation. Thinking innovation and society from a time-sensitive perspective. In: Jason Chilvers and Matthew Kearnes (eds.): Remaking participation: Science, environment and emergent publics. New York: Routledge, pp. 178–199.

Felt, Ulrike; Fochler, Maximilian (2010): Riskante Verwicklungen des Epistemischen, Strukturellen und Biographischen. Governance-Strukturen und

deren mikropolitische Implikationen für das akademische Leben. In: Peter Biegelbauer (ed.): Steuerung von Wissenschaft? Die Governance des österreichischen Innovationssystems. Innsbruck: StudienVerlag, pp. 297–328.

Ialenti, Vincent (2021): Drum breach. Operational temporalities, error politics and WIPP's kitty litter nuclear waste accident. In: Social Studies of Science 51 (3), pp. 364–391. https://doi.org/10.1177/0306312720986609

Joly, Pierre-Benoît (2015): Le régime des promesses technoscientifiques. In: Marc Audétat (ed.): Sciences et technologies émergentes. Pourquoi tant de promesses? Paris: Hermann, pp. 31–48.

Parotte, Céline; Fallon, Catherine (2020). The future for long-term management of high-level radioactive wastes and spent fuel in Belgium. Executive summary and epilogue. Available online at https://orbi.uliege.be/bitstream/2268/246178/3/Final_Report_WP3_Parotte_Fallon_2020.pdf, last accessed on 31.10.2022.

Saraç-Lesavre, Başak (2020): Deep time financing? 'Generational' responsibilities and the problem of rendez-vous in the U.S. nuclear waste programme. In: Journal of Cultural Economy 14 (4), pp. 435–448. https://doi.org/10.1080/17530350.2020.1818601

SACHA FRENAY
is master student of the Science and Technology Studies program from University of Liège and University of Maastricht.

DR. CÉLINE PAROTTE
is a lecturer at the Spiral Research Center, Research Unit Cité at University of Liège.

https://doi.org/10.14512/tatup.31.3.24

TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis
Journal for Technology Assessment in Theory and Practice

oekom

RESEARCH ARTICLE

‚We have a solution': Delivering on the promise to take national responsibility for nuclear waste management

Matti Kojo*[,1], Markku Lehtonen[2], Tapio Litmanen[3], Niina Kiviluoma[3]

Abstract • We examine the realization of the umbrella promise to assume national responsibility for the final disposal of spent nuclear fuel. Three case studies are used to illustrate how Finland delivers on the promise to take care of its own nuclear waste – a promise that has greatly contributed to the legitimacy of nuclear power in Finland. The article shows how this promise is being challenged by new competitors, business visionaries, and the public. The case studies illustrate the tensions between those who made the promise and the actors who interpret and mobilize the promise for varying purposes and under changing circumstances. We investigate techno-scientific promises by looking at debates about (1) the idea of a national solution, (2) the limitations that the promise of a national solution places on international business opportunities in the waste sector, and (3) the challenges related to credibility and spatial requirements in managing waste from small modular reactors.

‚Wir haben eine Lösung': Einlösung des Versprechens zur nationalen Verantwortung für die Entsorgung nuklearer Abfälle

Zusammenfassung • *Wir untersuchen die Umsetzung des Versprechens zur nationalen Verantwortung für die Endlagerung von abgebrannten Kernbrennstoffen. Anhand von drei Fallbeispielen wird gezeigt, wie Finnland das Versprechen umsetzt, sich um seinen eigenen Atommüll zu kümmern – ein Versprechen, das wesentlich zur Legitimität der Kernenergie in Finnland beigetragen hat. Der Artikel zeigt, wie dieses Versprechen durch neue Wettbewerber, unternehmerische Visionäre und die Öffentlichkeit infrage gestellt wird. Die untersuchten Fälle veranschaulichen die Spannungen zwischen denen, die das Versprechen abgegeben haben, und den Akteuren, die das Versprechen für unterschiedliche Zwecke und unter sich ändernden Umständen interpretieren und mobilisieren. Wir untersuchen technisch-wissenschaftliche Versprechen anhand von Debatten über (1) die Idee einer nationalen Lösung, (2) die Einschränkungen, die das Versprechen einer nationalen Lösung für internationale Geschäftsmöglichkeiten im Abfallbereich mit sich bringt, und (3) die Herausforderungen in Bezug auf Glaubwürdigkeit und räumliche Anforderungen bei der Entsorgung von Abfällen aus kleinen modularen Reaktoren.*

Keywords • *promises, nuclear waste, repository, Finland, responsibility*

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler. https://doi.org/10.14512/tatup.31.3.10*

Changing context, changing promises

The promise of national responsibility for the management of spent nuclear fuel (SNF) generated in the country has helped to make Finland a forerunner among the developers of deep geological disposal. Posiva[1], the nuclear waste management (NWM) company has proudly announced: "We have a solution" (Posiva Oy 2022). Other Finnish actors have frequently relayed the message. However, back in the early 1980s, the Finnish SNF management policy relied on the exportation of SNF and thus on international (Soviet and Western) nuclear fuel cycles. The policy

* *Corresponding author: matti.kojo@lut.fi*
[1] *LUT University, Lappeenranta, FI*
[2] *Pompeu Fabra University, Barcelona, ES*
[3] *University of Jyväskylä, Jyväskylä, FI*

https://doi.org/10.14512/tatup.31.3.31
Recieved: Jun. 10, 2022; revised version accepted: Oct. 21, 2022;
published online: Dec. 16, 2022 (peer review)

1 The mostly privately owned energy company Teollisuuden Voima (TVO) (60 %) and the mostly state-owned Fortum (formerly fully state-owned Imatran Voima, IVO) (40 %) are the shareholders of Posiva.

changed in 1994. The revised Nuclear Energy Act prohibited the export and import of nuclear waste and stipulated that nuclear waste generated in Finland (with the exception of waste from research reactors) must be permanently disposed of in the country itself (Sandberg 1999). Thus, Finland promised to take responsibility for its own nuclear waste. Eurajoki, the proposed repository siting municipality, also adhered to this idea, announcing in 2000 that it would accept only Finnish SNF for disposal on its territory (Kojo 2009, p. 184).

This article examines the ways in which the promise of national responsibility has been gradually transformed, in response to the changing context and as a result of active promise-construction work by the key actors. Three case studies from the post site selection phase in Finland serve as illustration. Document analysis and opinion surveys are used to illustrate the promises and their consequences, including the implications for the credibility of the promise in the eyes of residents.

The government issued a decision in principle (DiP) in 2000 for the final geological disposal of 4000 tU (from the Olkiluoto 1-2 and Loviisa 1-2 nuclear power plant (NPP) units), and confirmed Olkiluoto, in the municipality of Eurajoki as the site for the repository. In 2002, as part of the DiP for the new Olkiluoto 3 unit, the government approved the expansion of capacity by the 2500 tU that the new reactor was expected to produce. The construction permit for the encapsulation plant and the repository with a capacity of 6500 tU was granted in 2015. In 2021, Posiva submitted its application to operate the repository from 2024 until 2070.

The perspective of techno-scientific promises

The 'success story' of the Finnish nuclear waste management (Lehtonen 2021) can be described as a process of successfully constructing promises that are collectively experienced as credible and legitimate. Promises and expectations are vital to the development and deployment of techno-scientific innovations. They set things in motion by aligning actors, institutions, and capital; they "guide activities, provide structure and legitimation, attract interest and foster investment" (Borup et al. 2006, pp. 285–286; see also Joly 2010; van Lente 2012).

In this article, we focus on the continuous need to reshape and even radically transform the promise to ensure its legitimacy and credibility. We use the term techno-scientific promise to encompass 1. the relatively vague visions ('umbrella promises'), 2. more specific statements about the future of a given technology, and 3. the institutionalization and materialization of promises in policies, laws and regulation, funding decisions, projects, and commercial applications (Parandian et al. 2012). Promises vary in their degree of self-evidence and in their content (e.g., technical, commercial, societal, symbolic, and material aspects). Promises differ from other expectations in that they are, by definition, positive, as well as relational, that is, they entail interaction between 'promise-makers' and 'promise-takers'. The confrontation of promises and counter-narratives in debates between these rival groups can play a constructive role as 'trials of strength' that can strengthen the promise and its social robustness (Alvial-Palavicino 2015, pp. 158–159; Joly 2010).

Van Lente (2012) identified three main positive functions of promises: In particular, broad 'umbrella promises' legitimize investment by referring to a promising future; they provide direction by facilitating choice among options; and they help coordinate action by providing insight into the behavior of other actors in the system. When successful, promises create inescapable 'passage points', a sense that a particular technology is essential to achieving desired societal goals and visions (Joly 2010). More generally, promises link past, present, and future by drawing their power from historical precedents, on the one hand, and positive or negative future scenarios, on the other (Chateauraynaud and Debaz 2017).

The construction of umbrella promises of national responsibility

To explain why the promise of national responsibility for SNF management is crucial to the Finnish nuclear industry, we must first examine the origins and institutionalization of this umbrella promise, which can ultimately be traced back to Finland's accession to the European Union in 1995. The Finnish bedrock was repeatedly portrayed in the public debate as a potential target for imported nuclear waste – the horror picture was a 'graveyard' for foreign nuclear waste in Finland.

The emergence of the promise of national responsibility was also fueled by growing criticism of SNF exports from the Loviisa NPP to Russia. As a result, an amendment to the Nuclear Energy Act banned both exports and imports of nuclear waste. This, in turn, prompted IVO and TVO to establish a joint SNF management company, Posiva, in 1995, to help the companies meet their legal disposal obligation (Darst and Dawson 2010, pp. 67–69; Sandberg 1999; Nikula et al. 2012, pp. 37–39, 71).

Without explicitly using the term, the law essentially defines national responsibility by prohibiting the export and import of nuclear waste. The law states that "nuclear waste generated in connection with or as a result of use of nuclear energy in Finland shall be handled, stored and permanently disposed of in Finland" and that "nuclear waste generated in connection with or as a result of the use of nuclear energy elsewhere than in Finland shall not be handled, stored or permanently disposed of in Finland"[2].

The promise of national responsibility in Finland was further advanced by a change in policy, namely the abandonment of the reprocessing option. Initially, the policy envisioned reliance on the international nuclear fuel cycle, i.e., shipment of SNF abroad for reprocessing. Responsibility for the practical implementation and funding of NWM rests with licensees. No

2 Nuclear Energy Act 990/1987, 6 a, b.

 https://doi.org/10.14512/tatup.31.3.31

state nuclear waste agency has ever been established, although this option was included in the Atomic Energy Act in 1978 (Nikula et al. 2012, pp. 58–59, 64).

In 1981–1996, IVO transported SNF from its Soviet Loviisa-type NPP units to the Soviet Union and later to Russia, as agreed by the Finnish and Soviet governments in 1969 (Sandberg 1999, pp. 45–46). TVO also inquired about the availability of reprocessing services in several countries. The situation changed in the mid-1970s when the companies providing reprocessing services changed the terms of the contract and required that waste producers such as TVO commit to taking back and disposing of the remaining high-level waste after reprocessing. TVO also found the contract too expensive (Darst and Dawson 2010, pp. 65–66; Nikula et al. 2012, pp. 58, 79). In 1976, the Ministry of Trade and Industry established a working group to investigate NWM in Finland, and in 1978 and 1983, the government adopted the policy (Suominen 1999, pp. 25–26, 30–31). However, IVO could continue exporting SNF, because the Soviet Union did not require the return of residual waste.

Until the 1994 amendment of the Nuclear Energy Act, reprocessing was the primary objective for licensees, as defined in the 1983 policy decision. In the early 1980s, TVO started planning direct disposal of SNF in Finland, based on the Swedish KBS3 concept (Kojo and Oksa 2014a, pp. 24–25). At that time, the cost of reprocessing was estimated to be twice that of direct geological disposal (Nikula et al. 2012, pp. 77, 88). The import and export ban institutionalized the promise of national responsibility. In the following years, Posiva invoked this promise in its communications by emphasizing that it managed the nuclear waste generated by Finland's NPPs. The company presented itself as guardian of the nation's interests, not just those of its owners (Kojo 2002, p. 41). In addition, the Eurajoki host municipality announced in 2000 that it would only allow SNF from the Finnish NPPs at the Olkiluoto site (Kojo 2009, p. 184).

The case studies

Our first case study examines the transformation work and the dispute over the meaning of the relatively vague and visionary umbrella promise (Parandian et al. 2012). The case shows how this vision of ‚our solution' was first challenged by the Finnish energy companies. It illustrates the difficulties faced by a new entrant that wanted to join Posiva's repository project, and how the views of Posiva's owners about a possible expansion of the Olkiluoto repository underpinned the need for a second repository in Finland. To protect their interests, Posiva and its owners had to specify the umbrella promise.

Specifying the umbrella promise: the dispute over the promise of national responsibility

In 2007, the newly established energy company Fennovoima applied for a permit to build a new NPP and therefore needed to demonstrate that it had a reliable NWM solution. The company announced that it would manage its SNF jointly with Posiva. In doing so, Fennovoima emphasized national responsibility, arguing that Posiva had been established to manage all SNF generated in Finland in a single Finnish repository in Olkiluoto (Fennovoima 2009, p. 11). Posiva, however, developed a counter-narrative by invoking the principle of licensee-specific responsibility – the obligation of each energy company to take care of its own SNF. Posiva also argued that its owners would need the limited space in Olkiluoto for future energy production. It was also unwilling to dig disposal tunnels that would run under the sea or the NPP (Kojo and Oksa 2014b, p. 32.)

The promise of national responsibility has not only underpinned the rejection of reprocessing and long-term interim storage as unacceptable NWM solutions, but also helped to consolidate the position of nuclear power as a cornerstone of Finnish energy and climate policy. In its DiP application, Fennovoima (2009, p. 11) announced that it would develop and implement SNF disposal together with other Finnish utilities bound by the nuclear waste management obligations, to improve operational safety and reduce costs. Fennovoima further noted that the state could require licensees to cooperate if necessary to ensure the general welfare of society, as stipulated in the Nuclear Energy Act.

Parliament ratified the DiP for Olkiluoto 3 in 2002 and for Olkiluoto 4 and Fennovoima's Hanhikivi 1 in 2010. At the same time, the government approved Posiva's application to expand the final disposal capacity to accommodate SNF from Olkiluoto 3 and 4. The government gave Fennovoima six years to either agree on final disposal of SNF with TVO and Fortum or launch an Environmental Impact Assessment (EIA) procedure for its own repository (Finnish Government 2010, p. 16). Fennovoima's EIA program (Fennovoima 2016, pp. 16–17) indicated Eurajoki, albeit excluding the Olkiluoto site, as the first choice for repository, and the municipality of Pyhäjoki – the host of its planned new NPP – as the second option.

The promise of national responsibility failed to coordinate actions when a new player appeared on the scene. Posiva's shareholders, TVO and Fortum, repeatedly indicated that they were not interested in discussing final disposal with Fennovoima. They described Posiva as 'our solution', and the repository as designed to receive waste only from its owners' plants, including the possible new Olkiluoto 3 and 4 units – although the state is the majority owner of Fortum, it did not exercise its steering power on this issue (Kojo and Oksa 2014b, p. 18). Posiva explicitly ruled out nationalization and sought to strengthen its image as a private company accountable solely to its owners.

The ministry struggled to force the companies to cooperate on NWM. Cooperation in the form of know-how and provision of services came about only after the ministry established a joint working group with the companies in 2012 (Kojo and Oksa 2014b, pp. 33–38). Later, in 2016, Posiva's subsidiary Posiva Solutions signed an agreement with Fennovoima on technical expert services related to site selection (Lehtonen et al. 2021, p. 135), but Fennovoima was never allowed to participate in Posiva's SNF repository project.

https://doi.org/10.14512/tatup.31.3.31

Stretching the national responsibility to create business opportunities

Our second case study describes another shift in promise, provoked by recent initiatives that propose to turn NWM into a major business opportunity, building on Finland's reputation as a pioneer. For example, the former deputy director general of the International Atomic Energy Agency, Olli Heinonen, proposed building a few additional repositories in Finland for waste from abroad to make the country a model for others and reduce the risks of terrorism and proliferation (Heinonen 2012). To make this promise a reality, economic visionaries sought to extend the scope of the promise from national to international responsibility. This, in turn, would require lifting or softening the ban on waste imports.

Nearly half (43 %) opposed final disposal, and 46 % opposed long-term storage in their neighborhoods.

Two recent corporate initiatives illustrate the transformation: One launched by the start-up Avalon Energia established in 2017, and another by the Ecomodernist Society of Finland (ESF), a pro-nuclear NGO founded in 2015. To legitimize the promise, which he described in his LinkedIn-profile as safely disposing of "global high-level nuclear waste in a network of deep geological repositories in the bedrock of Finland", Robert Nemlander argued this would bring economic benefits to the host municipalities, the company, the government, and society at large, but would also help to create a better world for our children by combating climate change via greater use of nuclear power (Nemlander 2019, pp. 36–37). Importing waste would generate profits of some ten billion euros per year, that is, one trillion euros over the hundred years of the repository operation; enough to allow Finland to introduce universal basic income. If reprocessed, Nemlander argued on LinkedIn, the imported SNF could "power the entire planet with clean energy for over 70 years". Avalon's action plan highlights gaining public support and identifying repository sites as important steps on the path to Finnish NWM business.

In 2021, the ESF suggested legislation and research and development as tools for advancing Finnish NWM exports. The ESF proposed amending the Nuclear Energy Act to allow trade in SNF, as this would remove barriers to rational climate solutions and vast export opportunities for Finland in technologies such as nuclear-powered district heating. In addition, the amendment would help other countries to clean their energy systems, consolidate Finland's reputation as a low-carbon country, and enable Finland to export service packages for the entire nuclear energy life cycle including the handling of nuclear waste. Given Finland's pioneering role in responsible nuclear waste management, the change would also be ethically justified (ESF 2021 a).

For Avalon Energia, a network of repositories would pave the way for further construction of nuclear power. It predicted that "public support for nuclear energy skyrockets if the waste issue is solved" (Nemlander 2019, p. 22). Avalon described Finland as "the best chance for international HLW [high-level waste] repositories due to politics, geology, tech and limited time" (Nemlander 2019, p. 22) but saw permanent geological disposal only as a step towards the ultimate goal of recycling of HLW, once the technology would become available.

Like Avalon Energia, the ESF stressed the importance of waste management in the nuclear technology service packages (ESF 2021 b). The Society's suggestions aligned with calls from Finnish Energy, the Finnish energy-sector advocacy group, for a market-based and technology-neutral approach to NWM from small modular reactors (SMRs) to keep the door open for various disposal options, including reprocessing and SNF export. "The regulation should enable business in new areas of nuclear energy" and "guide solutions only to the extent necessary to ensure safety, security, and non-proliferation" (Finnish Energy 2021, p. 5).

Credibility of the promise: NWM of small modular reactors

A third challenge for the initial promise of national responsibility stems from the planned SMRs, and local residents' views on the options for managing SNF from such reactors. A positive expectation of citizens regarding SMR waste would be an indication that promise-building has succeeded in convincing a stakeholder group that is important for the development of the technology. Crucially, the decentralized nuclear power production model entailed in the SMR vision questions the promise of national responsibility. As nuclear power is increasingly framed as a key contributor to energy security and combat against climate change, SMRs have been suggested as a means of decarbonizing district heating, necessary for the cities in the Helsinki Metropolitan area to reach its CO_2 emission reduction targets. However, little attention has been paid to the management of nuclear waste from SMRs – a potential obstacle to the fulfilment of the SMR promise. Crucially, the option of siting the waste locally challenges the vision of a centralized national solution. Results from a resident survey conducted in the Helsinki metropolitan area in November 2021 reflect the ambiguities, hesitations and contradictions involved. Indeed, citizen's opinions were divided, both on the possible construction of SMRs and on the associated waste management options (Kojo et al. 2022).

Most respondents expressed reluctance to the idea that SNF accruing in SMRs should be handled at the local level. Nearly

 https://doi.org/10.14512/tatup.31.3.31

half (43 %) opposed final disposal, and 46 % opposed long-term storage in their neighborhoods.

However, in apparent contradiction with this reluctance to accept local solutions, 57 % of the respondents agreed that transporting waste generated by SMRs would be dangerous. The possibility of transnational waste trade faced mixed views: 45 % opposed the idea of disposing of imported nuclear waste at the Eurajoki site, while 48 % held a neutral opinion regarding a possible amendment to the Nuclear Energy Act that would allow SMR waste to be returned to the producer abroad.[3] Most respondents (60 %) favored a centralized solution to the final disposal of SMR waste. However, the preferred location of SMR waste management remained unclear, as half of the residents were neither clearly in favor nor against disposing of the waste in Eurajoki, the site of the original ‚national solution'.

Conclusions

In the past decades, the promise of national responsibility was a political statement used to allay fears that nuclear waste would be imported to Finland (after the country joined the European Union) and to demonstrate that nuclear waste from new NPP units would be managed responsibly. In the 1990s, the nuclear industry still believed that the construction of multinational repositories would conflict with the national disposal plan (Nikula et al. 2012, p. 92). Since then, the situation has changed. Some actors have suggested legislative changes that would allow imports and exports of nuclear waste, generate business opportunities, and diversify the options for managing waste from possible SMRs.

This article described the gradual transformation, in reaction to changing circumstances, of the umbrella promise that has underpinned the continuity and legitimacy of nuclear power in Finland, namely that the country takes care of its own nuclear waste. Changing policy circumstances and pressure from diverse involved actors have led to further specification and continuous disputes over the very nature of the promise of national responsibility, with attempts to redefine this responsibility in international rather than national terms. This promise-transformation work involved, first, the entry of a new player in the field. The incumbent players were unwilling to accept the new entrant, and prioritized licensee responsibility for SNF management over a national centralized repository solution. Second, the transformation of the business landscape further spurred a move away from the narrative of a centralized national solution, as the energy industry, start-ups, and ecomodernists brought to the table visions in which waste trade and SMRs would open lucrative new business opportunities, in the spirit of national interest. Third, the incipient efforts to bolster the legitimacy and credibility of the SMR vision in the eyes of the public are reflected in the relatively positive views among local residents concerning possible SMRs. However, the unresolved issue of how to deal with the waste from a possible decentralized SMR fleet divides residents' opinions and forces further changes to the initial version of the national responsibility promise, built on the vision of centralized waste management.

Earlier research on techno-scientific promises have often either stressed the role of hype-disappointment cycles (Parandian et al. 2012) or analyzed the various functions of promises (Van Lente 2012). Our case studies highlight the need to complement such analysis of the performative power of a given promise with more fine-grained studies of the ways in which the initial promise gets transformed through active transformation work undertaken by the involved actors, and how policy, innovation, promises as well as actor behavior and preferences co-evolve. In current Finnish NWM policy, such transformation efforts imply pressures towards more market-oriented policy approaches.

Funding • This work received funding from the KONE Foundation, project number 202105388 and from the Academy of Finland, project number 351173.

Competing interests • The authors declare no competing interests.

3 In 2016, almost three out of four of Finns disagreed with the statement "I accept the final disposal of nuclear waste generated abroad in Olkiluoto, if it is found to be safe", Aarnio et al. 2017, p. 19

References

Aarnio, Anna-Riikka; Kojo, Matti; Litmanen, Tapio (2017): Fennovoiman loppusijoituslaitoksen yhteiskunnallinen hyväksyttävyys. Miten suomalaiset suhtautuvat vaihtoehtoisiin paikkoihin? In: ATS Ydintekniikka 46 (3), pp. 16–20.

Alvial-Palavicino, Carla (2015): The future as practice. A framework to understand anticipation in science and technology. In: Tecnoscienza – Italian Journal of Science & Technology Studies 6 (2), pp. 135–172. Available online at http://www.tecnoscienza.net/index.php/tsj/article/view/239/159, last accessed on 08. 11. 2022.

Borup, Mads; Brown, Nick; Konrad, Kornelia; Van Lente, Harro (2006): The sociology of expectations in science and technology. In: Technology Analysis and Strategic Management 18 (3–4), pp. 285–298. https://doi.org/10.1080/09537320600777002

Chateauraynaud, Francis; Debaz, Josquin (2017): Aux bords de l'irréversible. Sociologie pragmatique des transformations. Paris: Editon Pétra.

Darst, Robert; Dawson, Jane (2010): Waiting for the nuclear renaissance. Exploring the nexus of expansion and disposal in Europe. In: Risk, hazards & crisis in public policy 1 (4), pp. 41–82. https://doi.org/10.2202/1944-4079.1047

ESF – Ecomodernist Society of Finland (2021 a): Käytetyn ydinpolttoaineen ja radioaktiivisen jätteen huollon kansallisen ohjelman luonnos ja ympäristöselostus. In: Lausunto, 10. 09. 2021. Available online at https://www.lausuntopalvelu.fi/FI/Proposal/Participation?proposalId=e01c4855-5b1f-4768-b41e-7e3392e07ad4, last accessed on 08. 11. 2022.

ESF (2021 b): Uutta Ydinvoimaa. Nyt! Avoin kirje työ- ja elinkeinoministeriölle. In: ekomodernismi.fi, 10. 9. 2021. Available online at https://ekomodernismi.fi/uutta-ydinvoimaa-nyt/, last accessed on 08. 11. 2022.

Fennovoima (2009): Ydinvoimalaitoksen periaatepäätöshakemus. s.l.: s.n. Available online at https://tem.fi/documents/1410877/2610955/Periaatep%C3%A4%C3%A4t%C3%B6shakemus, last accessed on 08. 11. 2022.

Fennovoima (2016): Käytetyn ydinpolttoaineen kapselointi- ja loppusijoituslaitoksen ympäristövaikutusten arviointiohjelma. s.l.: s.n. Available online at

https://tem.fi/documents/1410877/3326762/YVA-ohjelman+yhteenveto+2016, last accessed on 08. 11. 2022.

Finnish Energy (2021): Pienreaktorit (SMR) saatava pian osaksi uutta energiajärjestelmää. Positiopaperi 2021. s.l: s.n. Available online at https://energia.fi/files/6320/ET_SMR-positiopaperi_092021.pdf, last accessed on 08. 11. 2022.

Finnish Government (2010): Valtioneuvoston periaatepäätös 6. päivänä toukokuuta 2010 Fennovoima Oy:n hakemukseen ydinvoimalaitoksen rakentamisesta. Available online at https://www.eduskunta.fi/FI/vaski/Documents/m_4+2010.pdf, last accessed on 08. 11. 2022.

Heinonen, Olli-Pekka (2012): Ydinturva uusiksi. In: Talouselämä, 11. 09. 2012. Available online at https://www.talouselama.fi/uutiset/ydinturva-uusiksi/4fc566f0-d88d-3475-a685-012b41c5a321, last accessed on 08. 11. 2022.

Joly, Pierre-Benoît (2010): On the economics of techno-scientific promises. In: Madeleine Akrich, Yannick Barthe, Fabian Muniesa and Philippe Mustar (eds.): Débordements. Mélanges offerts à Michel Callon. Paris: Presse des Mines, pp. 203–221. https://doi.org/10.4000/books.pressesmines.747

Kojo, Matti (2002): Lahjomattomien haukansilmien valvonnassa. Ydinjätteen loppusijoitushankkeen hyväksyttävyyden rakentaminen Posiva Oy:n tiedotusmateriaalissa. In: Pentti Raittila, Pekka Hokkanen, Matti Kojo and Tapio Litmanen (eds.): Ydinjäteihme suomalaisittain. Tampere: Tampere University Press, pp. 36–66.

Kojo, Matti (2009): The strategy of site selection for the spent nuclear fuel repository in Finland. In: Matti Kojo and Tapio Litmanen (eds.): The renewal of nuclear power in Finland. Basingstoke: Palgrave Macmillan, pp. 161–191. https://doi.org/10.1057/9780230237032_6

Kojo, Matti; Kiviluoma, Niina; Litmanen, Tapio (2022): Kaukolämpöä pienydinvoimalla? Pääkaupunkiseudun asukkaiden näkemykset osallistumisesta ja päätöksenteosta. In: ATS Ydintekniikka 51 (2), pp. 39–43.

Kojo, Matti; Oksa, Anna (2014 a): Adaption of the Swedish KBS disposal concept to Finland. A technology transfer case study. Tampere: University of Tampere. Available online at https://urn.fi/URN:ISBN:978-951-44-9515-1, last accessed on 08. 11. 2022.

Kojo, Matti; Oksa, Anna (2014 b): The second repository for disposal of spent nuclear fuel in Finland. An analysis of the interests, resources and tactics of the key actors. Tampere: University of Tampere. Available online at https://urn.fi/URN:ISBN:978-951-44-9514-4, last accessed on 08. 11. 2022.

Lehtonen, Markku (2021): Das Wunder von ONKALO? Zur unerträglichen Leichtigkeit der finnischen Suche nach einem Endlager. In: APuZ – Aus Politik und Zeitgeschichte 71 (21–23), pp. 32–37.

Lehtonen, Markku; Kojo, Matti; Kari, Mika; Litmanen, Tapio (2021): Healthy mistrust or complacent confidence? Civic vigilance in the reporting by leading newspapers on nuclear waste disposal in Finland and France. In: Risks, Hazards & Crisis in Public Policy 12 (2), pp. 130–157. https://doi.org/10.1002/rhc3.12210

Nemlander, Robert (2019): International nuclear waste repository network. s.l.: s.n. Available online at https://www.slideshare.net/RobertNemlander/avalon-energia-business-deck, last accessed on 08. 11. 2022.

Nikula, Anneli; Raumolin, Heikki; Ryhänen, Veijo; Seppälä, Timo; Vira, Juhani; Äikäs, Timo (2012): Kohti turvallista loppusijoitusta. Ydinjätehuollon neljä vuosikymmentä. Eurajoki: Posiva Oy.

Parandian, Alireza; Rip, Arie; te Kulve, Haico (2012): Dual dynamics of promises, and waiting games around emerging nanotechnologies. In: Technology Analysis & Strategic Management 24 (6), pp. 565–582. https://doi.org/10.1080/09537325.2012.693668

Posiva Oy (2022): We have a solution which is an example for the whole world. Eurajoki: Posiva Oy.

Sandberg, Jorma (1999): Päättikö eduskunta geologisesta loppusijoituksesta jo vuonna 1994? Käytetyn ydinpolttoaineen huoltoa koskeva lainsäädäntö ja viranomaispäätökset. In: Tapio Litmanen, Pekka Hokkanen and Matti Kojo (eds.): Ydinjäte käsissämme. Suomen ydinjätehuolto ja suomalainen yhteiskunta. Jyväskylä: SoPhi, pp. 43–64.

Suominen, Petteri (1999): Ydinjätepolitiikan muotoutuminen Suomessa. In: Tapio Litmanen, Pekka Hokkanen and Matti Kojo (eds.): Ydinjäte käsissämme. Suomen ydinjätehuolto ja suomalainen yhteiskunta. Jyväskylä: SoPhi, pp. 15–42.

Van Lente, Harro (2012): Navigating foresight in a sea of expectations. Lessons from the sociology of expectations. In: Technology Analysis & Strategic Management 24 (8), pp. 769–782. https://doi.org/10.1080/09537325.2012.715478

ASSOCIATE PROF. MATTI KOJO
has over two decades long experience in studying nuclear waste policy issues. He works at the LUT University.

DR. MARKKU LEHTONEN
is a social scientist at the Pompeu Fabra University in Barcelona. His recent research focuses on megaprojects, techno-scientific promises, and public controversies in the nuclear energy sector.

PROF. TAPIO LITMANEN
is an environmental sociologist whose research has focused on environmental and health risks, particularly those related to nuclear technology. He works at the University of Jyväskylä.

NIINA KIVILUOMA
is a research assistant at the University of Jyväskylä, where she is at the final stages of her master's degree in sociology.

TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis
Journal for Technology Assessment in Theory and Practice

oekom

RESEARCH ARTICLE

Intergenerational justice starts now: Recognizing future generations in nuclear waste management

Lucas Schwarz*,[1]

Abstract • Intergenerational justice is an inherent component of nuclear waste management. By looking at challenges of intergenerational justice at various stages of the repository siting process, the following thesis is discussed: Current generations can anticipate notions of intergenerational justice by applying high procedural standards to enable equitable distribution between generations and thus adequately recognize the needs of future generations. Applying high standards in this context means a constantly critical, reflexive, and open process, without bias or selfishness. This requires representative bodies such as the German Council of the Young Generation ('Rat der jungen Generation') that act as a bridge to future generations.

Intergenerationale Gerechtigkeit beginnt jetzt:
Anerkennung künftiger Generationen bei der Entsorgung radioaktiver Abfälle

Zusammenfassung • *Intergenerationale Gerechtigkeit ist ein wesentlicher Bestandteil der nuklearen Abfallentsorgung. Anhand von Herausforderungen der intergenerationalen Gerechtigkeit während verschiedener Phasen des Standortauswahlverfahrens und der Endlagerung wird die folgende These diskutiert: Heutige Generationen können Vorstellungen von intergenerationaler Gerechtigkeit durch die Anwendung hoher Verfahrensstandards antizipieren, um eine gerechte Verteilung zwischen den Generationen zu ermöglichen und damit Bedürfnisse künftiger Generationen angemessen zu berücksichtigen. Die Anwendung hoher Standards bedeutet dabei einen konstant kritischen, reflexiven und offenen Prozess, ohne Voreingenommenheit und Eigennutz. Dies erfordert, dass repräsentative Gremien wie der ‚Rat der jungen Generation' als Brücke zu künftigen Generationen fungieren.*

Keywords • *nuclear waste, justice, repository, environmental justice, representatives*

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler. https://doi.org/10.14512/tatup.31.3.10*

On the importance of intergenerational justice

Notions of intergenerational justice are inherent to discussions about nuclear waste management. In Germany, the site selection process for a high-level nuclear waste (HLW) repository is ongoing. The target of the process is to find a geological formation that can guarantee the best possible safety for the disposal of nuclear waste for one million years. Additionally, the retrievability of nuclear waste shall be possible for 500 years after the initial deposit.[1] In comparison: The industrial revolution, which can be regarded as the foundation of modern-day Europe, took place around 250 years ago – this societal transformation is unmatched to this day. Social change takes place in shorter periods than the decay of nuclear material.

Current generations have to deal with a burden that was imposed on them by past generations and find themselves exposed to past decisions, that they could not (dis)approve. The legal basis for the site selection process in Germany, the 'Repository Site

* *Corresponding author: lucas.schwarz@fu-berlin.de*
[1] *Otto Suhr Institute of Political Science, Freie Universität Berlin, Berlin, DE*

https://doi.org/10.14512/tatup.31.3.37
Recieved: Jun. 10, 2022; revised version accepted: Oct. 21, 2022;
published online: Dec. 16, 2022 (peer review)

1 In German legislation there is a difference between reversibility and retrievability. Reversibility comprises the planned technical possibility to retrieve HLW during the operating phase, while retrievability refers to unplanned retrieval of HLW from a repository, Standortauswahlgesetz (RSS-Act), § 2.

Selection Act' (RSS-Act, StandAG) determines the "avoidance of unreasonable burdens and obligations for future generations"[2]. Choi and Matsuoka (2020) note that the forwarding of burdens (and benefits) from generation to generation is unavoidable. Current decisions will affect future generations: In the case of nuclear waste, this means that current generations will need to find a suitable repository site and future generations will bear the risk of a nuclear waste repository, without benefiting, e.g. via 'cheap' energy (Shrader-Frechette 2000). As decisions on energy infrastructure are often determined in a 'moral vacuum' (Jenkins et al. 2018), the inclusion of intergenerational justice requires serious and sincere consideration. Warren (2002) describes, that democratic inclusion relies on the opportunity of affected actors to influence a decision. Reciprocity is not achievable, as future generations cannot represent themselves personally, but rely on current generations to anticipate their needs: A dilemma arises that needs to be resolved for a nuclear waste repository site to be perceived as just from an intergenerational point of view.

The inclusion of intergenerational justice requires serious and sincere consideration.

The following thesis will be discussed: Intergenerational justice can be enabled by setting high standards in the procedure, distribution, and recognition within the current site selection process. The qualifier high describes that standards need to be critical, reflexive, and open for adaptation without bias or selfishness. Hence, justice for future generations is intrinsically linked to justice in current generations. Additionally, I provide challenges and opportunities for the long-term perspective of intergenerational justice.

State of research

Questions of intergenerational justice typically revolve around the extent of current generations' responsibilities (Blowers 2010), whether it is fair to deprive future generations of their flexibility (Leigh and Dotson 2011), or whether an inclusive discourse with future generations is possible. Spaemann (2003) states that merely a fictional dialogue is possible. Hocke (2021) complements that such a discourse is entirely in the hand of current generations, thus revealing a power asymmetry between current and future generations. Even in current generations, many different approaches fit the idea of acting responsibly towards future generations by either granting flexibility or freedom. This translates into the debate around reversibility and enclosure for an HLW repository (Ott and Semper 2017).

Gosseries (2008) states that intergenerational justice is achievable if the needs of future generations are not compromised upon by current generations. He argues that the capital (in its broadest sense; not narrowed down to a purely economic capital) that a current generation forwards to a future generation, should not be smaller than the capital that it received from a past generation. For nuclear waste, current generations have to deal with a legacy that was inherited from past generations. Additionally, future generations have to deal with possible consequences of decisions that will (not) be made by current generations. As current generations are future generations to past generations, and the nuclear waste legacy was forwarded, the inherent challenge of nuclear waste to notions of justice becomes apparent.

Liebig and Scheller (2007) attest that not only goods but also burdens need distribution and that the perception of justice of such distributions is based on different ideals of justice. Nonetheless, unequal distributions between people and generations require reasoning and explanation (Berger 2004). This is necessary for the repository, as all German HLW shall be stored in a central repository.

Tremmel (2021) describes two major concerns of intergenerational justice as the contradiction between (forgone) welfare and sovereignty. This is transferable to nuclear waste management: Kermisch (2016) provides an overview of different disposal options and differentiates between close and remote future generations. She concludes that "non-retrievable geological disposal appears to be the most favorable option for remote future generations" (p. 1809), but shows simultaneously that close and remote future generations might have different needs for a repository. The assessment between generations on how to interact with nuclear waste is therefore subject to temporal change (Kasperski and Storm 2020). Tremmel (2021) argues in favor of 'institutions for future generations.' This can be enabled by improving the political representation of children as links to future generations (Campos 2021). This representation needs to be understood as a representation of claim rights (Campos 2019).

Reversibility enables future generations to act flexibly regarding nuclear waste management thus granting them sovereignty over HLW, whereas enclosure grants a higher degree of freedom, without the obligation to act and thus to focus on then prevailing challenges. From another perspective reversibility can be regarded as a burden, as future generations might have to deal with HLW; while enclosure can be regarded as an obsta-

2 Repository Site Selection Act of 05. 05. 2017 (BGBl. I p. 1074), as last amended by Article 1, Section 2 of the Act of 07. 12. 2020 (BGBl. I p. 2760). Available online at https://www.gesetze-im-internet.de/standag_2017/StandAG.pdf (in German), last accessed on 17. 10. 2022.

 https://doi.org/10.14512/tatup.31.3.37

cle to correcting past decisions. The contradiction between reversibility and enclosure requires constant evaluation at fixed times and flexibility regarding the outcome (Tremmel 2017). From a critical perspective, Okrent (1999, p. 878) raises the question of whether "millions of dollars spent today to save a relatively few statistical lives thousands of years in the future," although this money could be used to save more lives in the present, can be regarded as intergenerationally just. While this question is fundamental, it is equally difficult to answer and will therefore be put aside.

From an environmental justice perspective, Schlosberg (2004) argues that justice is generally made up of three dimensions, namely procedure, distribution, and recognition. Against this background, intergenerational justice can be regarded as a part of recognition, with direct implications for procedure and distribution. In the following, I discuss that intergenerational justice can be enabled by setting high standards for procedure, distribution, and recognition within the current site selection process.

Aspect	Item	Reference
Recognition	Future generations have to be considered in the siting procedure for a repository.	Gosseries 2008; Hocke 2021
Reversibility	For the sake of future generations, the repository should be kept open.	Kermisch 2016; Tremmel 2021
Enclosure	For the sake of future generations, the repository should be immediately sealed.	Kermisch 2016; Tremmel 2021
Timely solution	A repository must be found quickly, to not burden future generations.	Röhlig et al. 2017
Time delays	The process may take longer than planned (a) for scientific reasons; (b) for participatory reasons.	RSS-Act 2017*; Leigh and Dotson 2011
Young generation	Intergenerational justice comprises the inclusion of the young generation.	Campos 2021, Tremmel 2021
Compensation	The repository community is entitled to generous financial compensation.	Kunreuther et al. 1990; Blowers 2010

* Repository Site Selection Act of 5th of May 2017 (BGBl I, p. 1074), as last amended by Art. 1 of the Act of 7th of December 2020 (BGBl I, p. 2760)

Tab. 1: Survey items. *Source: author's own compilation*

Intergenerational justice research often thematizes the dilemma or the challenge of reciprocity, representation, or hypothetical wants and needs of future generations. Especially in the case of nuclear waste management, there is a lack of empirical insights to assess how claims of intergenerational justice are manifested. By conducting a quantitative survey that is complemented by qualitative observations, this contribution provides exploratory insights into how intergenerational justice is perceived in the German site selection process.

Methods

This contribution draws on a quantitative survey carried out among interested citizens in Germany. The presented notions of justice were assessed in a survey that was carried out in the context of the German repository site selection process. 716 respondents were acquired via networking platforms from the ongoing site selection process, political working groups on environmental and energy politics, civil society organizations, as well as interested groups (via Facebook). The respondents were invited via mail or group post and two reminders to participate were sent. Additionally, in online events of the German site selection process, respondents were invited via public chat messages. The anonymous survey covered three dimensions of justice (procedure, distribution, recognition); adjacent factors such as trust, power, and emotions; and personal constituents, e.g. spatial proximity, experiences, and socio-demographics. Notions of intergenerational justice were part of six questions (Table 1). All items were formulated as statements. Respondents had to assess on a scale from 0 (low) to 10 (high) how strongly they (dis)approve of a statement. Each item is derived from the indicated sources.

Additionally, qualitative observations (systematic protocols with categories; Lamnek 2010, pp. 564–565) were carried out to gain additional insights. The categories for observations were derived from the RSS-Act. Justice was formulated as an open category. Observations of intergenerational justice were collected within this category. It was captured how actors in the site selection process refer to notions of (intergenerational) justice and future generations. 71 events were observed using systematic protocols, such as the sub-areas conference, (organizational) meetings between the events of the sub-areas conference, and thematic workshops as well as informational events organized by the German Federal Company for the Disposal of Nuclear Waste ('Bundesgesellschaft für Endlagerung') or by the Federal Office for the Safety of Nuclear Waste Management ('Bundesamt für die Sicherheit der nuklearen Entsorgung'). The findings of the observations were used in addition to the quantitative survey results, thus providing an empirical base for interpretation.

Results and discussion

As the meaning of intergenerational justice varies over time and the progress of nuclear waste disposal, the following section is structured chronologically: pre-siting decision, siting decision, and post-siting decision.

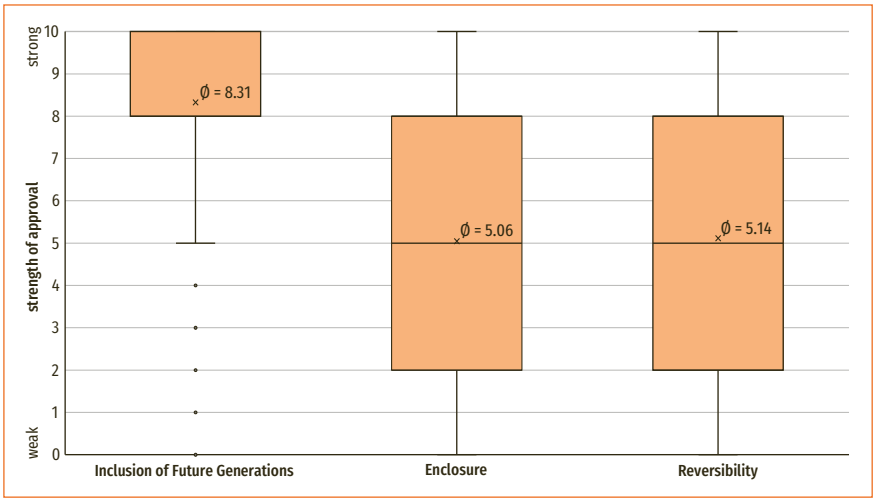


Fig. 1: Statements regarding future generations. *Source: author's own compilation*

Pre-siting decision

The consideration of future generations is apparent since the initiation of the current site selection process: The 'Repository Commission' wanted to achieve the least possible burden for future generations but at the same time to enable reversibility and retrievability (Röhlig et al. 2017). In the RSS-Act three time horizons are defined: (1) a repository site shall be found by 2031; (2) retrievability shall be possible for up to 500 years after enclosure; (3) nuclear waste has to be safely encapsulated for one million years[3]. Most actors assume that the first date is utopian and lately the Federal Company for the Disposal of Nuclear Waste has issued a statement that the repository will probably be found between 2046 and 2068 at the earliest.[4] Usually, discussions revolve around the 'one million years,' a humanly unimaginable time. The second period of 500 years is rarely thematized. Most actors focus on contemporary events, such as the conflict in Ukraine that strongly influences how people perceive the necessity to deal with nuclear waste (Brunnengräber 2022). Some actors call for a faster process while others emphasize the short-termism of societal events and insist on a solid scientific base for the site selection. Röhlig and Eckhardt (2017) insist that such ephemeral trends should not influence the safety or scientific base of the site selection.

Generally, the respondents approve that the wants and needs of future generations have to be considered in the site selection process (*Ø = 8.31, SD = 2.71*). This general approval is manifold in its implications. There is no clear tendency whether enclosure (*Ø = 5.06, SD = 3.42*) or reversibility (*Ø = 5.14, SD = 3.39*) is regarded as intergenerationally just. For both options all assessments were chosen by the respondents, thus showing that the actual path to achieve justice for future generations in this aspect is unclear.

The respondents do not attach any particular importance to a timely site decision (*Ø = 6.45, SD = 2.99*). Delays due to scientific reasons (*Ø = 8.34, SD = 2.20*) are more strongly approved, than delays due to participatory reasons (*Ø = 7.77, SD = 2.58*). This result is observable in the site selection process as well: Whereas in the 'Sub-areas Conference' (February-August 2021) many discussions revolved around how and when citizens can participate in the process, the last participatory conference – the 'Repository Siting Forum' (May 2022) – strongly revolved around methodological questions. An important development regarding intergenerational justice is the (bottom-up) foundation of the 'Council of the Young Generation' which aims to involve young participants in the site selection process. The council members argue that young people will actually experience the implementation of the repository and are therefore affected more strongly. Such institutions can help to build a bridge to the next generations if carried out constantly throughout the process (Campos 2021). This development provides an example of how procedural justice in the current process contributes to intergenerational justice in the future. The inclusion of younger generations is assessed positively by the respondents (*Ø = 7.28, SD = 3.12*). Such developments aim at long-term inclusion.

Through the establishment of the 'Council of the Young Generation', procedural justice has the potential to keep the procedure on a just path, exemplarily against short-termism or societal shocks. By applying high procedural (and scientific) standards, if society is accepted as a corrective of the site selection process, a responsible foundation for future generations can be laid. This requires continuity, as well as a flat (non-hierarchical) power relation between all involved actors (Schwarz et al. 2021).

Siting decision

The siting decision in Germany will be accompanied by a site agreement that comprises the definition of compensation for the affected host community. Kunreuther et al. (1990) have shown in the case of the U.S. that compensations can only work when the affected population has been able to convince itself that compensations do not function as bribes and that the process has a scientific basis. Lehtonen (2021) describes the kind of compensations that were carried out in the Finnish case; e.g. a senior residence, credits for an ice stadium, and economic development. In Switzerland, compensations are intended for the sustainable development of the host region and comprise 500 million CHF for a high-level waste repository site (Steinebrunner 2019).

3 StandAG, § 1 (2,4,5).

4 The statement is available here: https://www.base.bund.de/SharedDocs/Kurzmeldungen/BASE/DE/2022/zeitplan-endlagersuche.html;jsessionid=3EF4AD06D83CCD5356C3AF7FD3457A8C.2_cid382 or here https://www.bge.de/de/aktuelles/meldungen-und-pressemitteilungen/meldung/news/2022/11/bge-tritt-in-die-diskussion-ueber-den-zeitplan-bei-der-endlagersuche-ein/.

https://doi.org/10.14512/tatup.31.3.37

Compensations can be designed differently, which directly influences intergenerational justice. The need to compensate the host community is slightly approved (*Ø = 6.99, SD = 3.00*), but its implementation is contested: According to observational insights, actors of the anti-nuclear movement argue that compensations are necessary, but timing is crucial to avoid misuse of the mechanism. Compensations shall function as a mechanism to additionally develop a region that took responsibility for a national task. The height and mode of compensation cannot be part of the discussion before the site decision but only after the decision has been made. This only works if the participatory process is regarded as trustworthy (Seidl et al. 2013) and if compensations are not used as an incentive for structurally or financially weaker municipalities. Distributive justice for future generations can be achieved if externalities do not influence the siting decision. Exemplarily, the East German politician Kai Emanuel argues that structural change cannot end in a final repository in the East of Germany (NSDO 2020). A citizen forum on compensation might help to include the needs of future generations by including the Council of the Young Generation.

Nuclear waste knowledge preservation, e.g. by an atomic order or priesthood, seems necessary, but any entity made up of people can potentially be corrupted or destroyed.

Post-siting decision

Most currently living generations will not live to see the German repository. Scholars and state actors deal with the heritage of a nuclear waste repository. Heritage research deals with how people in the future can be warned of a repository site when the memory of its location will be lost. Kermisch (2016) estimates that such memory loss will happen approximately 500 years after closure. Questions of responsibility during this phase are rarely discussed in the ongoing site selection process. In contrast to this, different risks of accidentally causing damage to the repository have been discussed, such as accidents while drilling for geothermal energy or salt caverns. Such risks are – again – hypothetical, but taking precautions today is one way of considering the needs of future generations. One component of intergenerational justice is the safety of the repository from geological and human activities. While geological dangers will be addressed within the site selection process, human intrusion "poses the only real danger to [a] site's integrity" (Bryan-Wilson 2002, p. N/A). To communicate with future generations, different semiotic warning signs are considered.

Figure 2 symbolizes ideas to mark the repository site by repelling instead of attracting. The most prominent example is the 'Landscape of Thornes' (E) which "conveys a menacing aura of danger through its stylized inelegance and a repudiation of high-tech origins" (Bryan-Wilson 2002, p. N/A). Although the repository is a deep-geological structure, such a monument would be above-ground, thus effectively changing a landscape for the duration of its existence.

From an intergenerational perspective, such measures are imaginable, but their assessment of justice is ambiguous. The 'Landscape of Thorns' can be compared to ancient (from a current perspective) burial places that were intruded upon by Westerners. Danesi (2022) describes that warning signs change over time. They should therefore be re-designed constantly to ensure the repository's integrity from human intrusion. This constant attention poses challenges to intergenerational justice, nuclear waste knowledge preservation, e.g. by an atomic order or priesthood, seems necessary, but any entity made up of people can potentially be corrupted or destroyed. Such a project is already imagined in fictional novels (Hug 2021).

A monument is neutral but since there is no immediate threat from a repository, the question remains whether it only burns entire landscapes and creates emotional relations. Such questions can be answered by current generations, but need re-evaluation by future generations to guarantee future applicability. Therefore, intergenerational justice is – again – intertwined with jus-

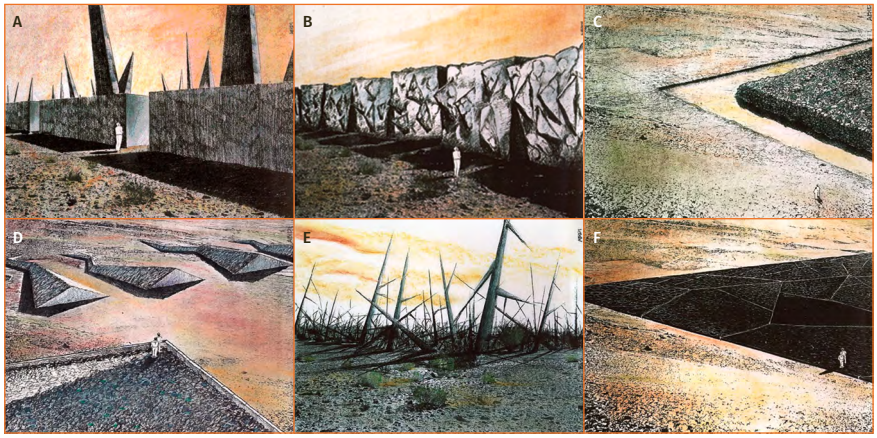


Fig. 2: Monuments to prevent human intrusion into the repository. *Source: Bryan-Wilson 2002*

tice in current generations. As potential problems do not need to stem directly from the deep-geological repository site the questions of the monument's location additionally requires consideration – alongside its implications for distributive justice in current and future generations.

Conclusion

The contradiction between enclosure and reversibility or phrased differently between (forgone) welfare and sovereignty (Tremmel 2021) is at the core of intergenerational justice for an HLW repository. The survey has shown that the respondents generally approve of including the needs of future generations in the site selection, but the actual implementation is contested. Following the findings of Campos (2021), first positive developments regarding intergenerational justice are observable in Germany, especially by the foundation of the Council of the Young Generation. Such an institution can help bridge the gap between current and future generations but requires constant participation and interest from young(er) participants. This is important as the council can embody a proxy for the abstract concept of future generations. By installing such a representative body, reasoning and explanations for unequal burdens can be critically discussed and improved (Berger 2004).

Bridging mechanisms and institutions are necessary: as Kermisch (2016) described how distant future generations might favor a certain type of repository, her assessment is based on certain assumptions made from a current point of view. Re-evaluation is necessary until a final decision needs to be made. Some paternalism of then-current generations toward future generations is inevitable, as future generations are affected by both indecision and actual decisions. By setting high standards for the site selection procedure, distribution, and recognition, current generations can enable a solid basis for future generations. As high standards comprise criticalness, reflexiveness, and openness for adaptation without bias or selfishness (derived from justice literature), they are subject to constant evaluation throughout the site selection process.

In this context, it is necessary to establish the Council of the Young Generation as a constant part of the site selection procedure. This council can act as a corrective and a reminder of the impact on and needs of future generations, as well as a proxy for their sovereignty in the site selection process for an HLW repository. This is necessary as current generations cannot solve this challenge alone, due to the longevity of HLW.

Whenever intergenerational justice is envisioned, it lays the groundwork for how other dimensions of justice will be approached in the future by people who have never benefited from nuclear energy but may have to deal with nuclear waste decisions. Such decisions will have to be made, especially if a flexible solution for a nuclear waste repository is chosen in the coming years (e.g., repository with retrievability or aboveground long-term storage). To achieve intergenerational justice, current generations must lay the groundwork by implementing a procedurally fair process with an equitable distributional outcome by recognizing the potential needs of future generations.

Funding • This research was conducted within the TRANSENS project ("Transdisciplinary Research on the Management of High-Level Radioactive Waste in Germany") and is funded by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), based on a decision by the German parliament, and within the funding initiative "Niedersächsisches Vorab der Volkswagenstiftung" by the Ministry for Science and Culture of Lower Saxony (MWK) from 2019 to 2024 (grant number 02E11849C).

Competing interests • The author declares no competing interests.

References

Berger, Johannes (2004): „Über den Ursprung der Ungleichheit unter den Menschen". Zur Vergangenheit und Gegenwart einer soziologischen Schlüsselfrage. In: Zeitschrift für Soziologie 33 (5), pp. 354–374. https://doi.org/10.1515/zfsoz-2004-0501

Blowers, Andrew (2010): Why dump on us? Power, pragmatism and the periphery in the siting of new nuclear reactors in the UK. In: Journal of Integrative Environmental Sciences 7 (3), pp. 157–173. https://doi.org/10.1080/1943815X.2010.506488

Brunnengräber, Achim (2022): Katastrophe in der Katastrophe. In: Berliner Zeitung, 06. 04. 2022. Available online at https://www.polsoz.fu-berlin.de/polwiss/forschung/grundlagen/ffn/forschung-alt/projekte/laufende/19_Transens/Brunnengraeber-Berliner-Zeitung-06-04-2022-AKW-im-Krieg.pdf, last accessed on 03. 11. 2022.

Bryan-Wilson, Julia (2002): Nuclear time. On markers to deter inadvertent human intrusion into the waste isolation pilot plant storage facility. In: Plazm Magazine 27. Available online at https://magazine.plazm.com/nuclear-time-on-markers-to-deter-inadvertent-human-intrusion-into-the-waste-isolation-pilot-plant-85a44d39e29b, last accessed on 03. 11. 2022.

Campos, Andre (2019): The rights of future persons under attack. Correlativity in the non-identity problem. In: Philosophia 47 (3), pp. 625–648. https://doi.org/10.1007/s11406-018-0022-6

Campos, Andre (2021): The British Academy Brian Barry prize essay. Representing the future: The interests of future persons in representative democracy. In: British Journal of Political Science 51 (1), pp. 1–15. https://doi.org/10.1017/S000712341900067X

Choi, Yunhee; Matsuoka, Shunji (2020): The relationship between trust, procedural justice, and distributive justice in high-level radioactive waste (HLW) management. In: Journal of Environmental Information Science 2020 (1), pp. 33–44. https://doi.org/10.11492/ceispapersen.2020.1_33

Danesi, Marcel (2022): Warning signs. The semiotics of danger. London: Bloomsbury Academic. https://doi.org/10.5040/9781350178335

Gosseries, Alex (2008): Theories of intergenerational justice. A synopsis. In: Surveys and perspectives integrating environment and society (S.A.P.I.E.N.S.) 1 (1), pp. 61–71. Available online at https://journals.openedition.org/sapiens/165, last accessed on 03. 11. 2022. https://doi.org/10.5194/sapiens-1-39-2008

Hocke, Peter (2021): Endlagerung hochradioaktiver Abfälle. In: Armin Grunwald and Rafaela Hillerbrand (eds.): Handbuch Technikethik. Stuttgart: J. B. Metzler, pp. 388–392. https://doi.org/10.1007/978-3-476-04901-8_74

Hug, Annette (2021): Tiefenlager. Roman. Heidelberg: Wunderhorn.

Jenkins, Kirsten; Sovacool, Benjamin; McCauley, Darren (2018): Humanizing sociotechnical transitions through energy justice. An ethical framework for global transformative change. In: Energy Policy 117, pp. 66–74. https://doi.org/10.1016/j.enpol.2018.02.036

Kasperski, Tatiana; Storm, Anna (2020): Eternal care. Nuclear waste as toxic legacy and future fantasy. In: Geschichte und Gesellschaft 46 (4), pp. 682–705. https://doi.org/10.13109/gege.2020.46.4.682

Kermisch, Celine (2016): Specifying the concept of future generations for addressing issues related to high-level radioactive waste. In: Science and Engineering Ethics 22 (6), pp. 1797–1811. https://doi.org/10.1007/s11948-015-9741-2

Kunreuther, Howard; Easterling, Douglas; Desvousges, William; Slovic, Paul (1990): Public attitudes toward siting a high-level nuclear waste repository in Nevada. In: Risk Analysis 10 (4), pp. 469–484. https://doi.org/10.1111/j.1539-6924.1990.tb00533.x

Lamnek, Siegfried (2010): Qualitative Sozialforschung. Weinheim: Beltz.

Lehtonen, Markku (2021): Das Wunder von Onkalo? Zur unerträglichen Leichtigkeit der finnischen Suche nach einem Endlager. In: Aus Politik und Zeitgeschichte 71 (21–23), pp. 32–37. Available online at https://www.bpb.de/apuz/333368/das-wunder-von-onkalo-zur-unertraeglichen-leichtigkeit-der-finnischen-suche-nach-einem-endlager, last accessed on 03. 11. 2022.

Leigh, Christi; Dotson, Lori (2011): Interim storage, environmental justice, and generational equity. American Nuclear Society, International High-Level Radioactive Waste Management Conference. Albuquerque, New Mexico, 11.–14. 04. 2011. Available online at https://www.osti.gov/servlets/purl/1141764, last accessed on 03. 11. 2022.

Liebig, Stefan; Scheller, Percy (2007): Gerechtigkeit zwischen den Generationen. In: Berliner Journal für Soziologie 17 (3), pp. 301–321. https://doi.org/10.1007/s11609-007-0027-7

NSDO – North Saxony District Office (2020): Landrat Emanuel. Strukturwandel kann nicht in Atommüll-Lager münden. In: Leipziger Zeitung, 28. 09. 2020. Available online at https://www.l-iz.de/melder/wortmelder/2020/09/Landrat-Emanuel-Strukturwandel-kann-nicht-in-Atommuell-Lager-muenden-351351, last accessed on 03. 11. 2022.

Okrent, David (1999): On intergenerational equity and its clash with intragenerational equity and on the need for policies to guide the regulation of disposal of wastes and other activities posing very long-term risks. In: Risk Analysis 19 (5), pp. 877–901. https://doi.org/10.1023/A:1007014510236

Ott, Konrad; Semper, Franziska (2017): Nicht von meiner Welt. Zukunftsverantwortung bei der Endlagerung von radioaktiven Reststoffen. In: GAIA – Ecological Perspectives for Science and Society 26 (2), pp. 100–102. https://doi.org/10.14512/gaia.26.2.9

Röhlig, Klaus-Jürgen; Eckhardt, Anne (2017): Primat der Sicherheit. Ja, aber welche Sicherheit ist gemeint? In: GAIA – Ecological Perspectives for Science and Society 26 (2), pp. 103–105. https://doi.org/10.14512/gaia.26.2.10

Röhlig, Klaus-Jürgen; Häfner, Daniel; Lux, Karl-Heinz; Hassel, Thomas; Stahlmann, Joachim (2017): Einschluss oder Zugriff. Tiefenlagerung ohne oder mit Vorkehrungen zur Rückholbarkeit. In: GAIA – Ecological Perspectives for Science and Society 26 (2), pp. 114–117. https://doi.org/10.14512/gaia.26.2.13

Schlosberg, David (2004): Reconceiving environmental justice. Global movements and political theories. In: Environmental Politics 13 (3), pp. 517–540. https://doi.org/10.1080/0964401042000229025

Schwarz, Lucas; Themann, Dörte; Brunnengräber, Achim (2021): Räume erobern, öffnen und verteidigen. Über die Wirkung von Macht beim dritten Beratungstermin der Fachkonferenz Teilgebiete. In: Forschungsjournal Soziale Bewegungen Plus 34 (4). Available online at https://forschungsjournal.de/fjsb-plus/schwarz-themann-brunnengraeber-raeume-erobern-oeffnen-und-verteidigen/, last accessed on 03. 11. 2022.

Seidl, Roman; Krütli, Pius; Moser, Corinne; Stauffacher, Michael (2013): Values in the siting of contested infrastructure: The case of repositories for nuclear waste. In: Journal of Integrative Environmental Sciences 10 (2), pp. 107–125. https://doi.org/10.1080/1943815X.2013.824486

Shrader-Frechette, Kristin (2000): Duties to future generations, proxy consent, intra- and intergenerational equity. The case of nuclear waste. In: Risk Analysis 20 (6), pp. 771–778. https://doi.org/10.1111/0272-4332.206071

Spaemann, Robert (2003): Ethische Aspekte der Endlagerung. In: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (ed.): Ethische Aspekte der Endlagerung. Bonn: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, pp. 25–63.

Steinebrunner, Martin (2019): The experience of the Swiss negotiated approach. Borders as a challenge. In: Achim Brunnengräber and Maria Rosaria Di Nucci (eds.): Conflicts, participation and acceptability in nuclear waste governance. An international comparison volume III. Wiesbaden: Springer, pp. 357–381. https://doi.org/10.1007/978-3-658-27107-7_18

Tremmel, Joerg (2021): The four-branches model of government. Representing future generations. In: Marie-Claire Cordonier Segger, Marcel Szabó and Alexandra Harrington (eds.): Intergenerational justice in sustainable development treaty implementation. Cambridge, U.K.: Cambridge University Press, pp. 754–780. https://doi.org/10.1017/9781108768511.045

Tremmel, Jörg (2017): Constitutions as intergenerational contracts. Flexible or fixed? (II) In: Intergenerational Justice Review 3 (1), pp. 4–17. https://doi.org/10.24357/igjr.3.1.716

Warren, Mark (2002): What can democratic participation mean today? In: Political Theory 30 (5), pp. 677–701. https://doi.org/10.1177/0090591702030005003

LUCAS SCHWARZ
is a research assistant in two projects (TRANSENS and COME RES). He is currently writing his doctoratal thesis on the just handling of high-level radioactive waste in Germany from a Latourian perspective.

https://doi.org/10.14512/tatup.31.3.37

RESEARCH ARTICLE

Citizen participation in the long-term process of high-level radioactive waste disposal: Future tasks and adequate forms of participation

Rosa Sierra*,[1], Konrad Ott[1]

Abstract • The central importance of public participation in the search for a repository site for high-level radioactive waste is already recognized both in Germany and in other countries. In this paper, we argue that public participation will have to play a role after site selection as well, especially in the political and sociotechnical decisions in the next stages of the final disposal process. The form of citizen participation should correspond to the specific tasks and follow the principles of safety and justice. In order to show in which cases these principles apply and which form of participation would then be appropriate, we analyze three aspects of participation (co-determination, co-design, and involvement) and look at two cases: the decision on the sealing of the repository and the design of compensations.

Bürgerbeteiligung im langfristigen Endlagerungsprozess:* *Künftige Aufgaben und angemessene Beteiligungsformen

Zusammenfassung • *Die zentrale Bedeutung der Öffentlichkeitsbeteiligung bei der Standortsuche für ein Endlager für hochradioaktive Abfälle ist sowohl in Deutschland als auch in anderen Ländern bereits anerkannt. Wir vertreten in diesem Beitrag die These, dass Bürgerbeteiligung auch nach der Standortentscheidung eine Rolle spielen sollte, insbesondere bei den politischen und soziotechnischen Entscheidungen in den nächsten Etappen des Endlagerungsprozesses. Die Form der Bürgerbeteiligung sollte den konkreten Aufgaben entsprechen und auf den Prinzipien Sicherheit und Gerechtigkeit beruhen. Um zu zeigen, in welchen Fällen diese Prinzipien Anwendung finden und welche Beteiligungsform dann angemessen ist, analysieren wir drei Aspekte von Beteiligung (Mitbestimmung, Mitgestaltung und Mitwirkung) und betrachten dazu zwei Fälle: die Entscheidung über den Verschluss des Endlagerbergwerks und die Kompensationsmaßnahmen.*

Keywords • *participation, high-level radioactive waste, compensation, justice, safety*

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler. https://doi.org/10.14512/tatup.31.3.10*

On the adequacy of participation techniques

Public participation in the long-term process of final disposal of high-level radioactive waste (HLW) has been already explored: concerning its type and extent in accordance to the purpose of the involvement and the stage in the decision-making process (Krütli et al. 2010), exploring the requirement of a learning process and its implications for the institutional actors involved (Brohmann et al. 2021) and considering particular requirements for a successful long-term governance, like place-attachment of the people at the repository site (Mbah and Kuppler 2021). In order to assess the role and modes of participation in the stages of the process after the site selection, our analysis mainly relies on the challenges posed by the characteristics of the problem itself. As Kamlage et al. (2019) argue, the ambitious participatory approach in the current search for a repository site in Germany emerged as a response to challenges posed not only by the failed attempt at Gorleben, but also due to the characteristics of the problem of radioactive waste disposal and its governance system.

* *Corresponding author: sierra@philsem.uni-kiel.de*
[1] *Philosophisches Seminar, Christian-Albrechts-Universität zu Kiel, Kiel, DE*

https://doi.org/10.14512/tatup.31.3.44
Recieved: Jun. 10., 2022; revised version accepted: Oct. 21, 2022;
published online: Dec. 16, 2022 (peer review)

The final disposal of radioactive waste is a complex and highly contested sociotechnical problem (Brunnengräber 2016; Ramana 2019). Its solution does not arise from a scientific or technical point of view alone. It also requires the involvement of different societal actors (Röhlig 2022; Brunnengräber and Di Nucci 2019; see also Skorupinski and Ott 2000) whose knowledge, interests and values are at stake. It also involves a political decision-making process since science alone cannot identify the single very best site. Political decisions in a democratic system, on its turn, require citizen participation at different levels if citizens are expected to endorse them and to identify with corresponding policies (Lafont 2020).

It is easy to claim and hard to refute that participation is inadequate if the underlying concept of adequacy remains undefined.

Under the general agreement that there should be public participation, there still may be disagreement between participants and process-owners (Krütli et al. 2010, p. 863) about the modes and forms that are (in)adequate at different stages of the disposal process. In the present stage, strong disagreement has led to protest and withdrawal from the process in Germany (Boettcher et al. 2021; Themann et al. 2021). To determine which form is 'adequate' is, however, wicked; it is easy to claim and hard to refute that participation is inadequate if the underlying concept of adequacy remains undefined.

The dynamic-functional approach assesses the adequacy of participation techniques based on a typology of participation forms and the requirements at different stages of the decision-making process (Krütli et al. 2010). In our contribution, we consider that additionally the adequacy-relation should be specified as well. To that end, we first examine different aspects of participation and then illustrate the idea of adequacy on the basis of two future tasks within the process of final disposal.

Three forms of participation

Our approach to participation follows a theory of deliberative democracy (Habermas 1992) as it has been specified in the concept of "environmental deliberative democracy" (Ott 2014, p. 291) and the "participatory conception of deliberative democracy" (Lafont 2020, p. 7). Both concepts offer important distinctions for situating the kind of participation that we want to stress in democratic decision-making processes.

Following Habermas, the concept of environmental deliberative democracy distinguishes between a) the core of the political system that has sufficient democratic input-legitimacy to make collective decisions with long-term consequences, b) a reasoning civil society, and c) an intermediate deliberative zone. Within this zone, committees, boards, academies, state authorities, think tanks, and representatives from science, trade-unions, churches etc. are involved in deliberative settings (Ott 2014, p. 225). Through participatory formats, citizens can take an active role within this intermediate zone. Such role is additional to the formally regulated options of political engagement either in civil society or by voting at elections. It is also additional to the governance processes within the core of the political system that involve local and federal authorities. This additionality must be taken into account when considering the appropriateness of formats. Participation enriches the role of citizenship in the intermediate zone, apart from the role of citizenship in civil society and as a voting electorate. Furthermore, participation may have some intrinsic value, but it has to be embedded in democratic ways of problem solving and not just be 'maximized' without further considerations.

From the point of view of participatory deliberative democracy, participation in decision-making processes corresponds to the capacity of citizens to effectively shape the policies to which they are subject so they can endorse them as their own (Lafont 2020, p. 2). The key aspect of participation is its contribution to the "macro-deliberative processes of opinion- and will-formation in the broader public sphere" (Lafont 2020, p. 31). The distinction between deliberation processes at the macro level, on the one hand, and deliberation at the micro and local levels, on the other hand, characterizes the concept of participation: Public participation in macro-deliberative processes is an essential component of the democratic ideal of self-government, the idea that citizens shape the policies to which they are subject. The aim at this level is maximal inclusion in deliberation. Approaches to participation at the other two levels have other purposes in mind: Improving the quality of micro-level deliberations, e.g., through participation in mini-publics, and strengthening problem-solving capacity at the local level through citizen participation (Lafont 2020, pp. 31–32).

In an analysis of fair democratic processes, two aspects of participation have been distinguished: participation as the greatest possible involvement of affected parties in a discussion and participation as the possibility of contesting and shaping the discussion agenda (Benhabib 2016, p. 213). If participation is a necessary condition for a fair process in the siting of radioactive and other types of repositories (Young 1983; English 1991), then Benhabib's distinction applies: One should have broad participation and participants should be entitled to shape the agenda. Sometimes it has been claimed that participation also should include final decision and veto power. Research on site selection processes shows, however, that participation as decision power is not seen by stakeholders as a necessary condition

https://doi.org/10.14512/tatup.31.3.44

for a fair procedure. Decision-making power is less important than transparency and access to information, as the selection process for a repository in Switzerland shows (Krütli et al. 2015, pp. 135–136). In the broader context of procedural justice, participation has been understood as "voice," i. e. as the possibility of presenting one's point of view within a decision-making process (Meyerson et al. 2021, p. 5) sometimes with the expectation of influencing the outcome (Schmidt 2018, p. 175). This last aspect is also stressed in the participatory approach of deliberative democracy (Lafont 2020, p. 32).

We want to complement the previous outline with a result from an interdisciplinary discussion on participatory aspects of procedural justice held at the workshop 'Ein faires und inklusives Verfahren?'. The workshop is part of the project Transdisciplinary Research on High-Level Radioactive Waste Management in Germany (TRANSENS) and took place at the University of Kiel in November 2021. The discussion on procedural justice was structured through the dialogue method 'Open Space Dialogue'. In the discussion, three German terms were associated with the meaning of participation. The result was the specification of the terms with reference to three elements in decision-making: preparation, process and outcome. However, unlike the 'ladder' conception of citizen participation (Arnstein 1969), the specification does not stress the higher or lesser degree of participants' decision power, but rather point out their involvement with respect to the (decision-making) *process*, its *outcome* and its *preparation*. This specification allows us to link the definitions presented above with those elements, making the following distinctions more suitable for our analysis of adequate participation forms in decision-making in the German final disposal process:

‚To have a say' ('mitbestimmen') is ambiguous, as it might refer to having real decision and veto power or just having the entitlement to present arguments in order to create an influence on the decision. In German language 'bestimmen' implies a capacity to decide as in, e.g., 'Hier bestimme ich!'. A way to resolve this semantic ambiguity is by drawing a distinction between a strong and a weak version. In the strong version, 'having a say' refers to the decision outcome and implies decision power (Young 1983, English 1991). In the weak version, it refers to the decision-making process and just means a real chance to present one's arguments in a deliberative setting, being close to the conception of participation as 'voice' (Meyerson et al. 2021).

‚To jointly shape' ('mitgestalten') refers to the deliberative decision-making process and not to the decision outcome, like in the weak sense of 'having a say'. It can be defined as taking up a point (an opinion, a statement or an argument) and reflecting upon it, in order to obtain something shared from it. Jointly shape means, thus, to reflect upon arguments being made in order to proceed to a commonly shared decision. In its deliberative sense, to jointly shape is similar to the understanding of participation in participatory deliberative democracy (Lafont 2021). Going beyond this understanding, it entails formal involvement in the decision-making process, not only the deliberation processes in the public sphere.

‚Being involved' ('mitwirken') refers, as in the case of jointly shaping, to the deliberations within the intermediate zone prior to the decision-making process and not to the decision outcome. Unlike jointly shaping, it does not entail formal involvement in decision-making, but rather involvement in the preparation of the decision-making process in formal and informal deliberation processes ("Entscheidungsvorbereitung"; Ott 2014, p. 296). It is discursive involvement in processes of finding solutions within the intermediate zone.

Participation in the stages after the site selection: two future tasks

As mentioned earlier, there are several approaches to evaluating the role and form of citizen participation in the long-term process of radioactive waste disposal. We agree with Krütli et al. (2010, pp. 863, 865) on the importance of examining the adequate 'type and extent' of participation for each stage of a decision-making process and considering the 'issue at hand', instead of just aiming for maximum inclusion. The modes of participation in future stages of the final disposal in Germany (KLA 2016, p. 252) will thus correspond to the particular tasks in a given stage. We now explore the task of compensating for possible harms and burdens during construction and operation (stages two and three) and the task of sealing the repository (stage five).

Decision on compensatory measures

After deciding on the location, the host community is selected as the one that lives at the site with the "best possible safety"[1]. If an adverse impact would affect the safety of the repository, immediate action would be taken to restore a safe condition. The case for compensation, however, remains even if the site is safe in technical terms. It supposes that local people are negatively affected by the overall process of constructing and governing a repository, or by its mere presence. This includes, e.g., noise, property damage, all kinds of political trouble, or bad reputation for the host community. Thus, the damages and burdens to be compensated do not include the risks of radioactive contamination, but only noise and property issues in terms of civil law and property law.

Negative impacts on the economy, the development perspectives and the quality of life of the population will be also compensated. In the siting process in Switzerland compensations ('Kompensationen') are carefully distinguished from payments ('Abgeltungen') that will be negotiated between the repository host community and the responsible for waste disposal as recognition for contributing to solve a national problem (BFE 2017, p. 3).

1 Repository Site Selection Act of 05. 05. 2017 (BGBl. I p. 1074), as last amended by Article 1, Section 2 of the Act of 07. 12. 2020 (BGBl. I p. 2760). Available online at https://www.gesetze-im-internet.de/standag_2017/StandAG.pdf (in German), last accessed on 17. 10. 2022. Cited below as StandAG.

 https://doi.org/10.14512/tatup.31.3.44

In the German case, such a distinction is implied, but there is not yet a defined term for the benefits that will be part of the Site Agreement. In the ongoing search for the repository site, it is planned to analyze which impacts a repository could have in the potential host communities that will be proposed in phase three of stage one for underground exploration. The socioeconomic potentials analysis will then offer a basis for the Site Agreement[2]. There, a plan for regional development to offset possible negative impacts on the host community should be already included.

A series of questions have to be specified concerning compensation measures, e.g., what exactly will be offered to whom and for how long. Defining which persons exactly count as being affected is not a simple matter since any definition will be arbitrary. Shall only persons in the host community count as being affected or also those in its surroundings? Should political units or mere distance to site be decisive? However this might be decided, the appropriate form of citizen participation in the case of determining what will be offered and how it will be used is the granting of decision power to those being affected. The argument relies on the notion of fair compensation itself. If a claim for compensation has been accepted, and if there are different options to fulfill this claim (money, resettlement, infrastructures etc.), and if the general principles of participation and deliberative setting ('jointly shape') are taken seriously in cases of compensatory justice, then it follows that the burden bearers should decide which compensation they prefer. If a burden X shall be compensated by either A, B, or C, and if A, B, and C are equally costly for the compensatory agency, and if the burden bearer prefers A over B and C, there are no reasons why the agency which takes the responsibility for the burden, should be entitled to decide against the preference of the burden bearer. From the perspective of the burden bearers, B and C would count as 'under-compensation.' For political reasons, there could be protests if a non-preferred option is forced on people affected by the burden.

At the transdisciplinary workshop 'Finanzieller Ausgleich für ein Atommüll-Endlager', held in Karlsruhe, Germany from 06 to 08 May 2022, we have proposed to engage citizens in discussions concerning compensations by means of the evaluation of compensation models and the development of new models on this basis. Beside the traditional models of direct payments or infrastructure development, the models of social or community benefits (Richardson 2010, p. 5; Lehtonen and Kojo 2019), the added value approach (NEA 2015, Kojo and Richardson 2019) and "postmaterialistic offers" (Ott and Riemann 2018, p. 54) appear as more suitable for developed regions. Compensation measures refer, in this sense, to novel kinds of prosperity and quality of lives at a site. At the workshop we took a first step towards developing compensation models: Two separate groups worked on basic aspects of compensations using the first two steps of 'Soft Systems Methodology'. Both groups included researchers, stakeholders and citizens. The results are still being assessed, but we want to stress here the relevance of the exercise: through work group, participants gained a more differentiated insight on basic aspects besides the type of burdens, e.g., the affected parties, the responsible parties, the possible ways of offsetting the burdens as well as possible limits or restrictions to this offsetting. Preliminary results show that from the participant perspective the concept of 'offsetting' and its possible limits need special attention. Compensation measures that really improve the situation in the host community of a repository have thus to include the perspective of that community.

The damages and burdens to be compensated include not only the risks of radioactive contamination, but also noise and property issues.

Repository sealing

Once the radioactive waste has been stored in a geological formation, a decision should be made among finally sealing the repository, keeping it accessible, or retrieving the waste. Although we cannot foresee how future generations will decide at the turn to the next century, a basic combination of positions can be outlined. We simplify the case by taking only the option 'sealing,' and the positions 'in favor' or 'against'. We further consider three groups of actors: people living in the host community, the nation-wide population, and the Parliament. Of the three possible scenarios, 1. a consensus (or broad majority) in favor of sealing the repository, 2. a consensus (or broad majority) against sealing, or 3. no consensus, i. e., disagreement on the matter, we assume that 3. is likely. Thus, we assume that the details of repositories will be as contentious in the future as they are today.

Similar to Eckhardt (2021, p. 22), we assume in our analysis that predominant values in present day Germany will not be fundamentally different in the long-term. For sure, a weakening of the democratic system cannot be fully excluded, but if a functioning democracy still exists in Germany in the moment of the decision to sealing or not, it can be assumed that learning institutions could adapt or be transformed according to changing values, which could be still negotiated in democratic processes of public opinion and will formation and transformation. Thus, assuming that there will be democratic structures in situation 3, the question will be who gets the authority to decide and who should take costs and liability to govern an un-sealed repository. In its final report, the commission states that, from today's point of view, the decision cannot be in the hands of the operator and the licensing authority, but must again be taken by Par-

2 StandAG § 16, see also § 10 (4).

liament, as is the case in the present siting decision (KLA 2016, p. 270). The issue at stake speaks in favor of this assessment: In the case of repository sealing, considerations about safety and justice are both relevant. Assuming that the future world could be full of problems (the effects of climate change, a war near the repository site), it seems imperative to free future people from the risks and burdens of managing an accessible repository (Ott 2020, pp. 180–181). At the same time, making the repository inaccessible seems to violate their right to decide, i. e., would impose the decision of the then-living over future people and restrict their freedom of action (Ott 2020, p. 183; Riemann 2017, p. 164). The decision-making power should then be entrusted to an institution that is capable of legitimately balancing the various interests. Assuming democratic nation states in the future, we cannot envisage a better institution than freely elected parliaments. Local actors will not be able to decide on behalf of the entire citizenry, and a nationwide plebiscite in its present form is not compatible with the basic law.

Nation-wide, the public should be involved in the deliberative preparation of the decision-making process. For this purpose, they could profit from an ongoing discourse on HLW management if the knowledge base is maintained (for a present example see Röhlig 2022). In this way, the tasks and responsibilities, advantages and disadvantages of an open repository can be part of the public opinion formation. The mode of participation for the local citizens should be, however, more than just being involved. Local authorities at the host community should have formal access to the hearings concerning the sealing, giving the local citizens the possibility of shaping the decision-making process. Local interests/values must be considered not only in the search for a site but also in the case of sealing because they would probably change after the repository is built. In both cases, local interests and public interests should be balanced, and local authorities can be a "connecting link" between the national authorities and the local citizens (Mbah and Kuppler 2021, pp. 433–435).

The adequacy-relation between tasks and participation forms

Citizen participation will have to play a central role in further stages of the process after the site selection. In addition to 'voice' and 'vote,' a participatory interpretation of deliberative democracy stresses the importance of involving citizens in deliberative settings within the intermediate zone between political power and civil society. This holds true for the complex and highly contested process of HLW disposal in particular. Relying on the two cases above, we can now specify the idea of adequacy of participation forms according to the principles of justice and safety:

For a task or problem that implies only or primarily justice aspects, like compensation of negative impacts, the adequate form of participation is granting the affected parties real decision power. Different actors, including scientists and stakeholders, may jointly work on novel compensatory models, but affected parties should finally decide which compensatory options they prefer and how to spend the means.

For a task or problem that concerns both safety and justice aspects, in which safety and security are given priority, citizen participation without decision power is appropriate. This holds true for the case of sealing the repository. The extent of influence should be greater than mere 'involvement,' but not so strong as veto-power, especially if this is granted to particular groups, e.g., some minority groups in the future favoring a 'rolling stewardship' concept of long-term governance. Citizen participation in the form of 'jointly shaping' the decision-making process is, in this case, the adequate form.

Cases that concern primarily safety issues, e.g., container technologies, need to be analyzed in order to assess the appropriate participation mode. According to Krütli et al. (2010, pp. 870–871), decisions on safety issues would rely on experts and allow a lesser degree of public participation, although some 'active' forms of participation as 'public reviewing' could still prove fruitful. The peculiar societal dialectics between 'risk' and 'danger' (Luhmann 1991) give a strong risk-theoretical reason why persons who feel endangered should not decide if stakes are high, but should put pressure on experts that safety and security be optimized in given safety cases. To do that, the intermediate deliberative zone and thus the mode of 'being involved without decision power' would be the appropriate one. It is also probable that concepts of safety change over time. For integration of new concepts in long-term final disposal governance (Mbah and Kupler 2021, pp. 417–418), citizen involvement in the intermediate zone would be adequate.

Further elaboration should also allow to identify demands for participation which are inadequate. Making the adequacy-relation between participation modes and tasks more transparent is important for two reasons: first, a missing or unclearly defined adequacy-relation could be a source for many kinds of criticism, protest, and failure. Second, and more important, a clear adequacy-relation might be an alternative to mere demands for 'more participation'. Maximizing participation might come at the expense of legitimate state's power to act and to find a solution being acceptable to the entire citizenry.

Even with a transparent adequacy condition there still are other risks within participation that emerge if agents adopt a strategic attitude within deliberative settings. Participation can be strategically misused by groups which take a primary interest in de-legitimizing the state. There can be hidden agendas being pursued in participatory formats. There might be kinds of excessive participation with much political rhetoric, but without deliberative content. We regard it important to mention these risks of failure, but it would take another article to analyze them in detail from a discourse-ethical perspective. Making adequacy-relations between tasks and formats more transparent might still improve participation policies in general and, hopefully, even within the site selection process in particular and specifically after site selection in Germany.

 https://doi.org/10.14512/tatup.31.3.44

Funding • This work was funded by the research project 'Transdisciplinary Research on High-Level Radioactive Waste Management in Germany' (TRANSENS, www.transens.de).

Competing interests • The authors declare no competing interests.

References

Arnstein, Sherry (1969): A ladder of citizen participation. In: Journal of the American Institute of Planners 35 (4), pp. 216–224. https://doi.org/10.1080/01944366908977225

Benhabib, Seyla (2016): Kosmopolitismus ohne Illusionen. Menschenrechte in unruhigen Zeiten. Berlin: Suhrkamp.

BFE – Bundesamt für Energie (2017): Verhandlungsrahmen ("Leitfaden") für den Verhandlungsprozess von Abgeltungen/Kompensationen. Zürich: Eidgenössische Technische Hochschule Zürich. Available online at https://www.newsd.admin.ch/newsd/message/attachments/49818.pdf, last accessed on 07. 11. 2022.

Boettcher, Sascha; Freitag, Silke; Kostka, Dieter; Schüler, Roland (2021): Mediator:innen distanzieren sich vom aktuellen Standort-Suchverfahren. s.l.: s.n. Available online at https://www.umweltmediation.info/fileadmin/documents/MediatorInnen_distanzieren_sich_vom_aktuellen_Standortsuchverfahren_20210706.pdf, last accessed on 07. 11. 2022.

Brohmann, Bettina et al. (2021): Öffentlichkeitsbeteiligung bei der Endlagersuche. Herausforderungen eines generationsübergreifenden, selbsthinterfragenden und lernenden Verfahrens, Vorhaben 4717F00001, Endbericht. Berlin: Bundesamt für die Sicherheit der nuklearen Entsorgung. Available online at https://www.oeko.de/fileadmin/oekodoc/abschlussbericht_oe_herausforderungen_verfahren.pdf, last accessed on 07. 11. 2022.

Brunnengräber, Achim (2016): Das wicked problem der Endlagerung. In: Achim Brunnengräber (ed.): Problemfalle Endlager. Gesellschaftliche Herausforderungen im Umgang mit Atommüll. Baden-Baden: Nomos, pp. 145–166. https://doi.org/10.5771/9783845278131

Brunnengräber, Achim; Di Nucci, Maria Rosaria (2019): Conflicts, participation and acceptability in nuclear waste governance. Wiesbaden: Springer. https://doi.org/10.1007/978-3-658-27107-7

Eckhardt, Anne (2021): Stressfaktor Mensch. Menschliche Einflüsse auf das verschlossene Endlager. Versuch einer wissenschaftlichen Annäherung. TRANSENS-Bericht 3. Zollikerberg: s. n. https://doi.org/10.21268/20210615-0

English, Mary (1991): Siting, justice, and conceptions of the good. In: Public Affairs Quarterly 5 (1), pp. 1–17. Available online at https://www.jstor.org/stable/40435766, last accessed on 07. 11. 2022.

Habermas, Jürgen (1992): Faktizität und Geltung. Beiträge zur Diskurstheorie des Rechts und des demokratischen Rechtsstaats. Frankfurt a. M.: Suhrkamp.

Kamlage, Jan-Hendrik; Warode, Jan; Mengede, Anna (2019): Chances, challenges and choices of participation in siting a nuclear waste repository. In: Achim Brunnengräber and Maria Rosaria Di Nucci (eds.): Conflicts, participation and acceptability in nuclear waste governance. Wiesbaden: Springer, pp. 91–110. https://doi.org/10.1007/978-3-658-27107-7_6

Kojo, Matti; Richardson, Phil (2019): The use of the added value approach in siting radioactive waste facilities. In: Achim Brunnengräber and Maria Rosaria Di Nucci (eds.): Conflicts, participation and acceptability in nuclear waste governance. Wiesbaden: Springer, pp. 207–228. https://doi.org/10.1007/978-3-658-27107-7_11

KLA – Kommission Lagerung hoch radioaktiver Abfallstoffe (2016): Abschlussbericht. Verantwortung für die Zukunft. Ein faires und transparentes Verfahren für die Auswahl eines nationalen Endlagerstandortes. s.l.: s.n. Available online at https://www.bundestag.de/resource/blob/434430/35fc29d72bc9a98ee71162337b94c909/drs_268-data.pdf, last accessed on 07. 11. 2022.

Krütli, Pius; Stauffacher, Michael; Flüeler, Thomas; Scholz, Roland (2010): Functional-dynamic public participation in technological decision-making. Site selection processes of nuclear waste repositories In: Journal of Risk Research 13 (7), pp. 861–875. https://doi.org/10.1080/13669871003703252

Krütli, Pius; Törnblom, Kjell; Wallimann-Helmer, Ivo; Stauffacher, Michael (2015): Distributive versus procedural justice in nuclear waste repository siting. In: Behnam Taebi and Sabine Roeser (eds.): The ethics of nuclear energy. Cambridge, U. K.: Cambridge University Press, pp. 119–140. https://doi.org/10.1017/CBO9781107294905.007

Lafont, Cristina (2020): Democracy without shortcuts. A participatory conception of deliberative democracy. Oxford: Oxford University Press. https://doi.org/10.1093/oso/9780198848189.001.0001

Lehtonen, Markku; Kojo, Matti (2019): The role and functions of community benefit schemes. In: Achim Brunnengräber and Maria Rosaria Di Nucci (eds.): Conflicts, participation and acceptability in nuclear waste governance. Wiesbaden: Springer, pp. 175–205. https://doi.org/10.1007/978-3-658-27107-7_10

Luhmann, Niklas (1991): Soziologie des Risikos. Berlin: De Gruyter.

Mbah, Melanie; Kuppler, Sophie (2021): Raumsensible long-term governance zur Bewältigung komplexer Langzeitaufgaben. In: Bettina Brohmann, Achim Brunnengräber, Peter Hocke and Ana María Isidoro Losada (eds.): Robuste Langzeit-Governance bei der Endlagersuche. Soziotechnische Herausforderungen im Umgang mit hochradioaktiven Abfällen. Bielefeld: transcript, pp. 413–446.

Meyerson, Denise; MacDermott, Therese; Mackenzie, Catriona (2021): Procedural justice and relational theory. London: Routledge. https://doi.org/10.4324/9780429317248

NEA/OECD – Nuclear Energy Agency/Organisation for economic co-operation and development (2015): Fostering a durable relationship between a waste management facility and its host community. Paris: OECD Publishing. Available online at https://www.oecd-nea.org/upload/docs/application/pdf/2020-12/7264-fostering-durable-relationship-2015.pdf, last accessed on 07. 11. 2022.

Ott, Konrad (2014): Deliberative Zwischenreiche und Umweltpolitik. In: Joachim Hruschka and Jan Joerden (eds.): Jahrbuch für Recht und Ethik 22. Berlin: Duncker & Humblot, pp. 289–312.

Ott, Konrad (2020): Zur Einlagerung hochradioaktiver Reststoffe aus ethischer und politischer Sicht. Bestandsaufnahme und Ausblick. In: Anna Horatschek (ed.): Competing knowledges. Wissen im Widerstreit. Berlin: De Gruyter, pp. 171–188. https://doi.org/10.1515/9783110659658-010

Ott, Konrad; Riemann, Moritz (2018): „Volenti non fiat iniuriam". Freiwilligkeit und Bereitwilligkeit bei der Übernahme von Standortverantwortung. In: Konrad Ott and Ulrich Smeddinck (eds.): Umwelt, Gerechtigkeit, Freiwilligkeit – insbesondere bei der Realisierung eines Endlagers. Beiträge aus Ethik und Recht. Berlin: BWV, pp. 42–60.

Ramana, M. V. (2019): Why technical solutions are insufficient. The abiding conundrum of nuclear waste. In: Achim Brunnengräber and Maria Rosaria Di Nucci (eds.): Conflicts, participation and acceptability in nuclear waste governance. An international comparison. Volume III. Wiesbaden: Springer, pp. 21–38. https://doi.org/10.1007/978-3-658-27107-7_2

Richardson, Phil (2010): Community benefits and geological disposal. An international review. Oakham: Galson Sciences LTD. Available online at http://www.westcumbriamrws2013.info/documents/140-Community_Benefits_International_Review_by_Galson_Sciences.pdf, last accessed on 07.11.2022.

Riemann, Moritz (2017): Gerechtigkeit an der Oberfläche. In: Denis Köhnke et al. (eds.): Zwischenlagerung hoch radioaktiver Abfälle. Randbedingungen und Lösungsansätze zu den aktuellen Herausforderungen. Wiesbaden: Springer, pp. 159–171. https://doi.org/10.1007/978-3-658-19040-8_9

Röhlig, Klaus-Jürgen (ed.) (2022): Nuclear waste. Management, disposal and governance. Bristol: Institute of Physics Publishing.

Schmidt, Volker (1997): Procedural aspects of distributive justice. In: Klaus Röhl and Stefan Machura (eds.): Procedural justice. London: Routledge, pp. 161–179. https://doi.org/10.4324/9780429444524-8

Skorupinski, Barbara; Ott, Konrad (2000): Technikfolgenabschätzung und Ethik. Eine Verhältnisbestimmung in Theorie und Praxis. Zürich: vdf Hochschulverlag.

Themann, Dörte; Di Nucci, Rosaria; Brunnengräber, Achim (2021): Alles falsch gemacht? Machtasymmetrien in der Öffentlichkeitsbeteiligung bei der Standortsuche für ein Endlager. In: Forschungsjournal Soziale Bewegungen 34 (1), pp. 1–10. Available online at https://umweltfairaendern.de/wp-content/uploads/2021/07/fjsb-plus_2021-1_brunnengraeber_nucci_themann.pdf, last accessed on 07.11.2022.

Young, Iris-Marion (1983): Justice and hazardous waste. In: Bowling Green studies in applied philosophy 5, pp. 171–183. https://doi.org/10.5840/bgstudies1983514

DR. ROSA SIERRA
is a postdoctoral researcher in the working group Dialoge und Prozessgestaltung in Wechselwirkung von Recht, Gerechtigkeit und Governance (DIPRO) of the research project TRANSENS at the Philosophy Department of the University of Kiel since 2020. Her research fields include justice theories and compensation, future ethics, sustainability and transdisciplinarity.

PROF. DR. KONRAD OTT
holds the professorship on Environmental Philosophy and Ethics at the Philosophy Department of the University of Kiel since 2012. He was a member of the German Advisory Council on the Environment (SRU) and is author of numerous publications on environmental ethics, sustainability and technology assessment, among others.

TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis
Journal for Technology Assessment in Theory and Practice

oekom

RESEARCH ARTICLE

Commoning in der Standortsuche für ein Endlager?: Neue Wege kollektiven Handelns

Dörte Themann*,[1]

Zusammenfassung • Der Beitrag setzt sich mit der Frage auseinander, ob die Forschung von Elinor Ostrom zur Commons Governance neue Deutungsmöglichkeiten in Bezug auf derzeitige Institutionalisierungsprozesse im Verfahren der Standortsuche und generell für den Umgang mit hochradioaktiven Abfällen eröffnen kann. Basierend auf teilnehmenden Beobachtungen werden Hypothesen entwickelt, inwieweit dabei Logiken des Commoning verfolgt werden und erste Ergebnisse präsentiert.

Commoning in the search for a repository site?: New ways of collective action

Abstract • *This article addresses the question of whether Elinor Ostrom's research on commons governance can open up new interpretive possibilities with regard to current institutionalization processes in the site selection process and for dealing with high-level radioactive waste in general. Based on participatory observations, hypotheses are developed as to what extent logics of commoning are pursued, and preliminary results are presented.*

Keywords • *nuclear waste governance, commoning, collective action, self-organization*

This article is part of the Special topic "The future of high-level radioactive waste disposal: What are the developments and challenges after site selection?," *edited by U. Smeddinck, A. Eckhardt and S. Kuppler.* *https://doi.org/10.14512/tatup.31.3.10*

* *Corresponding author: d.themann@fu-berlin.de*

[1] *Forschungszentrum für Nachhaltigkeit, Freie Universität Berlin, Berlin, DE*

https://doi.org/10.14512/tatup.31.3.51
Recieved: Jun. 18, 2022; revised version accepted: Oct. 21, 2022;
published online: Dec. 16, 2022 (peer review)

Einleitung

Hochradioaktive Abfälle stellen eine Ewigkeitslast dar (Brunnengräber 2019). Eine solche Last verbleibt oftmals als eine Art „unbeabsichtigte Öffentlichkeit" (inadvertent publicness) (Kaul 2012, S. 49) in staatlicher Verantwortung. Die Privatwirtschaft hat hohe Gewinne mit der Kernenergie erwirtschaftet, doch die Risiken und unbeantworteten Fragen des Umgangs mit den Abfällen wurden an den Staat und damit die Öffentlichkeit übergeben. Sie können als „negatives Gut" (Ott 2020, S. 174) oder ‚public bad' (Schulz 2016; Brunnengräber und Mez 2014) betrachtet werden, also eine Art öffentliches ‚Ungut'. Diese Konzipierung weist auf ein Governance-Konzept hin, das bisher kaum Eingang in die Debatte des Umgangs mit hochradioaktiven Abfällen gefunden hat, dessen Potenzial aber für die angesprochenen ‚Ungüter' zu ergründen ist: die *Commons Governance* (Ostrom 2013). Diese beschreibt Wege kollektiven Handelns jenseits rein staatlicher Verwaltung oder marktwirtschaftlicher Zugänge, um Gemeingüter oder öffentliche Güter zu produzieren und zu verwalten.

Risiken und unbeantwortete Fragen des Umgangs mit den Abfällen wurden an den Staat und damit die Öffentlichkeit übergeben.

Das Standortsuchverfahren für ein Endlager für hochradioaktive Abfälle in Deutschland stellt in diesem Zusammenhang eine aufschlussreiche Fallstudie dar, weil mit dem Standortauswahlgesetz (StandAG) und dem Neustart des Verfahrens eine neue Institutionenarchitektur etabliert wurde. Der vorliegende Beitrag geht der Frage nach, inwiefern im Prozess Logiken des *Commoning* verfolgt werden. Hierzu wurden die Fachkonferenz Teil-

1. Klare Grenzen	Es ist definiert, welche Stakeholder bzw. Gruppen zur Nutzung des Commons berechtigt sind und auch die Grenzen des gemeinsam hergestellten oder zur Verfügung stehenden Gutes sind klar umrissen.
2. Regeln bzgl. Bereitstellung und Nutzung einer Ressource sind verhältnismäßig	Regeln in Bezug auf die Nutzung eines Commons müssen im ausgewogenen Verhältnis zu den Bereitstellungsregeln stehen, die Zeit, Arbeit, Geld oder anderweitige Ressourcen erfordern sowie auch den lokalen Bedingungen entsprechen. Bei Unverhältnismäßigkeit kann dies zu Inakzeptabilität der Regeln führen.
3. Gemeinschaftliche Entscheidungen	Personen, die von den operativen Regeln bzgl. des gemeinsamen Gutes betroffen sind, sollen an deren Entwicklung und Änderungen mitwirken können.
4. Monitoring bzw. Kontrolle	Kontrolle zum Zustand des Gutes sowie zur Einhaltung der Regeln und Verhalten der Nutzer*innen durch „Überwacher*innen". Diese Überwacher*innen können laut Ostrom die Nutzer*innen selber sein oder rechenschaftspflichtige Dritte. So wird Vertrauen in Kooperation ermöglicht.
5. Abgestufte Sanktionen	Abgestufte Sanktionen kommen zum Einsatz, falls Nutzer*innen die vereinbarten operativen Regeln verletzen. Außergewöhnliche Umstände oder Missverständnisse werden berücksichtigt und erlauben eine Fehlerkultur, die Personen ermutigt, die gegen Regeln verstoßen haben, sich wieder an diese zu halten.
6. Konfliktlösungsmechanismen	Es gibt schnelle und leicht zugängliche Arenen sowie einfache Mechanismen zur Konfliktlösung zwischen Nutzer*innen oder zwischen Nutzer*innen und ihren Bevollmächtigten.
7. Anerkennung des Organisationsrechts	Anerkennung des Organisationsrechts und des Rechtes der Nutzer*innen eigene Institutionen auszubilden durch staatliche Behörden und entsprechende Regierungsebenen.
8. Polyzentrische Governance	Verschachtelte Institutionen und Einbettung unterschiedlicher Organisationseinheiten in verschiedenen Ebenen, wenn das Common Teil eines komplexeren Systems ist. Umfangreiche Institutionen sind notwendig, um eingebettete Organisationseinheiten zu verbinden.

Tab. 1: Design-Prinzipien nach Ostrom.
Quelle: eigene Darstellung basierend auf Ostrom 2013; Poteete et al. 2010

gebiete sowie weitere Veranstaltungen, die in diesem Rahmen stattfanden, mittels teilnehmender Beobachtung wissenschaftlich begleitet. Der nachfolgende Text bietet einen Einblick in erste Auswertungen des Datenmaterials, aus denen Hypothesen für die vertiefende Analyse abgeleitet werden. Am Ende steht ein Ausblick, welche Impulse für die Standortsuche und darüber hinaus von der Commons Governance ausgehen können.

Commoning

Selbstverwaltete Institutionen und polyzentrische Systeme wurden „in Zeiten voranschreitender Demokratisierung" laut Ostrom zu lange übersehen und deren Bedeutung falsch eingeschätzt (Ostrom 2009, S. 222). Obwohl in der Commons Governance Prinzipien für erfolgreiches, langfristiges, selbstorganisiertes, kollektives Handeln identifiziert wurden, spielt sie in der Auseinandersetzung um die Ausgestaltung demokratischer Prozesse und politischer Ordnung angesichts zunehmender Risikoentscheidungen bisher kaum eine Rolle. Dabei hat die Forschung um Commons und Praktiken des Commoning in den letzten Jahren auch Einzug in gesellschaftstheoretische Debatten gehalten (Euler 2020; Helfrich 2012, 2009). Darüber hinaus gibt es vereinzelte Arbeiten, die sich mit der Übertragung dieses Konzeptes auf den Umgang mit langfristigen technologischen Effekten beschäftigen (Stern 2011). Neben den klassischen „common-pool resources", die Ostrom (2013, S. XVII) betrachtete, lässt sich der Blick auch erweitern auf „common-pool hazards" (Stern 2011, S. 225).

Logik des Commoning

Laut Quilligan sind Commons „Dinge, die Menschen gemeinsam nutzen und verwalten, indem sie, basierend auf Traditionen oder sozialen Normen und Praktiken, ihre eigenen Regeln aushandeln" (Quilligan 2012, S. 99). Ein Gut wird somit nicht nur durch seine materielle oder immaterielle Natur zum Commons, sondern vor allem durch die soziale Praxis und Strukturen, die Menschen ihm gegenüber gemeinschaftlich entwickeln und organisieren – genannt „Commoning". Commoning umfasst dabei ein gemeinsames Tun, mit dem Ziel, Regeln und Praktiken zur Nutzung und Bereitstellung eines Gemeingutes zu vereinbaren (Linebaugh 2008; Euler 2018; Meretz 2012). Sehr unterschiedliche Güter, wie etwa auch Wissen, können somit zu Commons werden, weil diese Charakterisierung von den jeweiligen sozialen Praktiken abhängt.

Wesentliche Dimension von Commoning ist die Institutionalisierung einer Form von Selbstorganisation. McGinnis (2011, S. 6) definiert Selbstorganisation bzw. „Self-governance" als "the capacity of any group of individuals to work together to resolve common problems and realize shared aspirations. Ideally, members of a self-governing community organize themselves so they can actively participate in all (or at least the most important) decision processes relating to their own governance". Selbstorganisation ist stark auf das zu erhaltende oder zu produzierende Common gerichtet und mit der Autonomie der Beteiligten oder Betroffenen verbunden, Ziele, Regeln und Organisationsformen in Bezug auf das Common bewusst selbst festzulegen.

Ostrom hat durch die Analyse hunderter Fallstudien acht Design-Prinzipien einer erfolgreichen und langlebigen Commons Governance identifiziert (Tab. 1). Sie bieten weitere Anhaltspunkte, um Logiken des Commoning in der Standortsuche zu erkennen, sowie gegenwärtige Problemlagen zu analysieren.

https://doi.org/10.14512/tatup.31.3.51

Methodisches Vorgehen

Der Handlungszusammenhang, der im Folgenden genauer betrachtet wird, ist die Fachkonferenz Teilgebiete, also das erste gesetzlich festgelegte Beteiligungsformat im Standortauswahlverfahren, deren drei Beratungstermine zwischen Februar 2021 und August 2021 stattfanden, sowie das Folgeformat Forum Endlagersuche im Mai 2022. Die Fachkonferenz Teilgebiete war die erste formelle Öffentlichkeitsbeteiligung laut Deutschem Standortauswahlgesetz[1] (StandAG) und hat den Zwischenbericht Teilgebiete, den die Bundesgesellschaft für Endlagerung im September 2020 vorlegte, öffentlich beraten. Das Forum Endlagersuche hingegen ist ein informelles Beteiligungsformat, das aus der Fachkonferenz Teilgebiete hervorging und als Brückenformat bis zu den Regionalkonferenzen (StandAG § 10) dienen soll. Die drei Beratungstermine der Fachkonferenz Teilgebiete, das Forum Endlagersuche sowie die öffentlichen Sitzungen der jeweils vorbereitenden Gruppen wurden von der Autorin mittels teilnehmender Beobachtung (Thierbach und Petschick 2019) wissenschaftlich begleitet (Abb. 1). Hierzu wurde ein Beobachtungsbogen mit Kategorien angelegt, die Interaktionen und Prozesse aber auch Äußerungen zu bestimmten Inhalten u. a. Konfliktgegenstände, Äußerung von Werten oder Rollenzuweisungen abdeckten. Der Bogen war aber nur teilweise vorstrukturiert, um offen für das Geschehen zu sein. Die nachfolgenden Aussagen basieren auf einer ersten explorativen Analyse des Materials, aus der heraus Hypothesen und vorläufige Ergebnisse abgeleitet werden, die im Verlauf einer noch folgenden vertieften Analyse mittels Grounded Theory (Glaser und Strauss 1979) weiter untersucht werden. Weitere Beobachtungen sowie Interviews sind geplant, um die Datengrundlage zu verbreitern. Wo möglich, werden die nachfolgenden Aussagen um Statements aus den Wortprotokollen oder Sekundärliteratur ergänzt, um die Ableitung entsprechender Hypothesen zu untermauern.

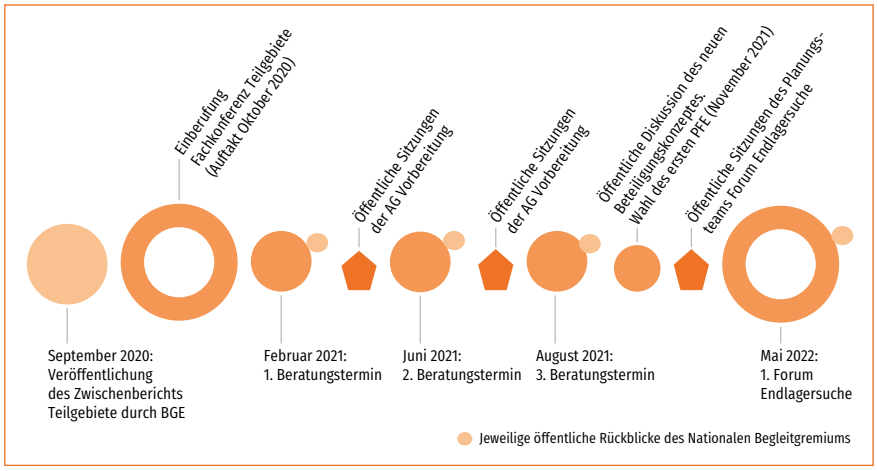


Abb. 1: Zeitlicher Verlauf der wesentlichen öffentlichen Veranstaltungen im Rahmen der Fachkonferenz Teilgebiete und des Forum Endlagersuche. *Quelle: eigene Darstellung*

Standortauswahlverfahren – neue Wege kollektiven Handelns?

Wunsch nach Selbstorganisation

Mit Veröffentlichung des Teilgebieteberichtes im September 2020 durch die Bundesgesellschaft für Endlagerung – die Vorhabenträgerin – und der daraufhin einberufenen Fachkonferenz Teilgebiete hat das Verfahren der Standortsuche in Deutschland eine neue Dynamik erfahren. Es kam während der Fachkonferenz Teilgebiete zu einer starken Auseinandersetzung um geeignete Organisationsformen der Beteiligung, die in Konflikten um die Mitgestaltungsmöglichkeiten der Öffentlichkeit sowie um die Selbstorganisationsform und Rollenverständnisse mündete (Themann, Di Nucci und Brunnengräber 2021; Themann, Schwarz et al. 2021; Schwarz et al. 2021 a, 2021 b). Während der Fachkonferenz Teilgebiete wurden die Teilnehmer*innen aus den laut StandAG zu beteiligenden Teilöffentlichkeiten (Bürger*innen, gesellschaftliche Organisationen, Wissenschaft, Gebietskörperschaften) zusammenfassend als „Zivilgesellschaft" bezeichnet. In diesem Text wird diese Zusammenkunft innerhalb der Fachkonferenz Teilgebiete als ‚erweiterte Zivilgesellschaft' bezeichnet und in Abgrenzung dazu Organisationen wie der Bund für Umwelt und Naturschutz Deutschland e. V. als ‚organisierte Zivilgesellschaft'. Die organisierte Zivilgesellschaft, und im Verlauf der Fachkonferenz Teilgebiete auch große Teile der erweiterten Zivilgesellschaft, argumentierten für eine kontinuierliche Selbstorganisationsmöglichkeit der Öffentlichkeit bis zu den Regionalkonferenzen (§ 10 StandAG) mit dem Bundesamt für die Sicherheit der nuklearen Entsorgung (BASE) in einer operativ unterstützenden Rolle. Exemplarisch wird die Aussage eines Teilnehmers während des zweiten Beratungstermins der Fachkonferenz Teilgebiete angeführt:

> „[…], weil der Zwischenbericht Teilgebiete weit hinter den Erwartungen zurückgeblieben ist, beginnt man jetzt zu improvisieren. Das bedarf der genauen Beobachtung. Gerade deswegen ist jetzt in den nächsten Jahren weiterhin eine selbstorganisierte Begleitung dieses Verfahrens durch die Zivilgesellschaft unerlässlich." (BASE 2021 a, S. 37)

Dieser Wunsch nach zivilgesellschaftlichen Beobachtungsmöglichkeiten innerhalb des Prozesses gegenüber der Bundesgesell-

1 Standortauswahlgesetz vom 05. 05. 2017 (BGBl. I S. 1074), das zuletzt durch Artikel 1 des Gesetzes vom 07. 12. 2020 (BGBl. I S. 2760) geändert worden ist. Online verfügbar unter https://www.gesetze-im-internet.de/standag_2017/StandAG.pdf, zuletzt geprüft am 17. 10. 2022.

https://doi.org/10.14512/tatup.31.3.51

schaft für Endlagerung (BGE) wird mit dem Ziel des bestmöglich sicheren Standortes verbunden. Dem liegt die Annahme zugrunde, dass durch eine zusätzliche Arena des kritischen Hinterfragens mögliche Fehlentwicklungen oder Lücken entdeckt werden und so das Verfahren gestärkt wird. Daraus entwickelte sich in der Themen-AG ‚Beteiligung und Transparenz' der Fachkonferenz Teilgebiete ein Antrag für ein Anschlussformat, das die Beteiligungslücke bis zu den Regionalkonferenzen schließen und in selbstorganisierter Form die Arbeiten der Bundesgesellschaft für Endlagerung weiter begleiten und hinterfragen soll. Um diese Selbstorganisationsmöglichkeit zu schaffen, wurde ein Forum als Raum angedacht, aus dem heraus sich die Zivilgesellschaft konstituieren und organisieren kann (Gaßner 2021). Dieser Antrag wurde mittels Abstimmung mehrheitlich durch die Teilnehmer*innen der Fachkonferenz Teilgebiete angenommen (BASE 2021 c). In den Worten der Commons Governance haben die ‚Nutzer*innen' der Beteiligungsstrukturen, also die erweiterte Zivilgesellschaft, damit einen ersten Schritt getan, um neue kollektive Arenen zu etablieren und Formen der Selbstorganisation zu verstetigen.

Das BASE hat diesem Organisationsvorschlag beim dritten Beratungstermin eine Form kollaborativer Governance gegenübergestellt, in der das Bundesamt stärker in Strukturen rund um das Folgeformat involviert ist und dieses gemeinsam mit Vertreter*innen der erweiterten Zivilgesellschaft bereitstellen möchte. Eine Selbstorganisation, wie von der Fachkonferenz Teilgebiete angedacht, wurde von Seiten des BASE eher kritisch gesehen (BASE 2021 b), wobei es eine Begründung schuldig blieb.

Nach der Fachkonferenz Teilgebiete folgten, unter Begleitung des Partizipationsbeauftragten, Beratungen zu einem neuen Beteiligungskonzept für den Zeitraum zwischen Fachkonferenz Teilgebiete und Regionalkonferenzen. Diese Beratungen fanden statt zwischen dafür mandatierten Vertreter*innen der Fachkonferenz Teilgebiete, dem BASE, der Bundesgesellschaft für Endlagerung sowie dem Nationalen Begleitgremium. Die Ergebnisse wurden im November 2021 öffentlich für alle Interessierten zur Diskussion gestellt und mündeten in das Forum Endlagersuche sowie das Planungsteam Forum Endlagersuche.

Bereits im Laufe der Fachkonferenz Teilgebiete haben etliche Akteure der organisierten Zivilgesellschaft das Beteiligungsverfahren verlassen (Schwarz et al. 2021 a). Die noch verbleibenden Teile der organisierten Zivilgesellschaft im Verfahren konnten sich der Organisationsform für das Forum Endlagersuche und das Planungsteam Forum Endlagersuche nicht anschließen, da sie den Anspruch der Selbstorganisation der Öffentlichkeit durch die aktive Rolle des BASE mit seinem Stimmrecht im Planungsteam Forum Endlagersuche unterlaufen sahen. Die Distanzierung organisierter Zivilgesellschaft vom Verfahren wurde zuletzt offenkundig durch die geringe Teilnehmer*innenzahl aus der Gruppe gesellschaftlicher Organisationen auf dem ersten Forum Endlagersuche im Mai von nur sechs bis neun aktiv teilnehmenden Personen, sowie durch nur eine vorhandene Kandidatur für das neue Planungsteam Forum Endlagersuche (PFE), das zur Vorbereitung des nächsten Forum Endlagersuche neu gewählt wird. Konstitutionell ist diese Form kollektiven Handelns also nicht durch alle zu beteiligenden Gruppen legitimiert. Und auch innerhalb des Planungsteam Forum Endlagersuche ist zu beobachten, dass die Rollen der verschiedenen Akteure sowie die Art der Zusammenarbeit weiterhin Gegenstand von Konflikten sind.

Prinzipien der Commons Governance: Reflexionspunkte im Standortsuchprozess

Diese Beobachtungen legen nahe, dass Beteiligung als gemeinsames Gut verstanden wird mit dem Ziel, den „Standort mit der bestmöglichen Sicherheit" (StandAG § 1 (2)) zu finden. Mittels Selbstorganisation der Beteiligung will die erweiterte Zivilgesellschaft eine zusätzliche Instanz schaffen, um das Verfahren von außen begleiten und hinterfragen zu können. ‚Sicherheit' wird somit als ein gemeinsames und nicht allein durch staatliche Organisationen zu gewährleistendes Gut konstruiert. In dem Wunsch nach kritischer Begleitung der Arbeit der Bundesgesellschaft für Endlagerung verdeutlicht sich das Ostromsche Prinzip von Kontrolle, die mit einer gewissen Autonomie gegenüber den staatlichen Organisationen ausgeübt werden soll. Die Sicherheit des Standortes als etwas gemeinsam zu produzierendes, sowie eine eigene Arena der Kontrolle, sind vor dem Hintergrund bisheriger sozialwissenschaftlicher Analysen plausibel – etwa zur Anwendung der Decide-Announce-Defend-Strategie in der Vergangenheit (Kamlage et al. 2019) sowie zum verlorenen Vertrauen in die staatlichen Organisationen im Umgang mit hochradioaktiven Abfällen (Di Nucci et al. 2021; KLHRA 2016).

‚Sicherheit' wird als ein gemeinsames und nicht allein durch staatliche Organisationen zu gewährleistendes Gut konstruiert.

Eine besondere institutionelle Position als „unabhängige Begleitung" (StandAG § 8 (1)) des Verfahrens und speziell der Öffentlichkeitsbeteiligung hat dabei das Nationale Begleitgremium. Es füllt womöglich eine Art ‚überwachende' Rolle aus, wie Ostrom sie für das Prinzip 4 identifizierte. Das Zusammenspiel zwischen den Nutzer*innen der Beteiligungsstrukturen und dem Nationalen Begleitgremium in seiner Wächterrolle mit seinen diversen Kompetenzen scheint dabei ein wichtiger Punkt für die vertiefte Analyse.

Ebenfalls in Zusammenhang mit Prinzip 4 betonen die organisierte wie auch erweiterte Zivilgesellschaft, dass sie Ressourcen für die Einbindung von wissenschaftlicher Expertise benötigten, um überhaupt eine Kontrollfunktion bzgl. der Arbeits-

 https://doi.org/10.14512/tatup.31.3.51

schritte der Bundesgesellschaft für Endlagerung wahrnehmen zu können. Der Wunsch nach Zugang zu unabhängigem fachlichen Wissen, um den Zustand der Sicherheit eigenständig beurteilen zu können, so die Hypothese, konstruiert fachliche Expertise somit als ein Gemeingut. Zumal sich, entgegen dem immateriellen Charakter von Wissen, Rivalitäten entwickeln können: „Der Markt ist leergefegt. BASE und Bundesgesellschaft für Endlagerung haben bereits alles an Expertise beauftragt. Wir finden kaum noch Leute, die für uns ein Gutachten unabhängig übernehmen können" äußerten Vertreter*innen organisierter Zivilgesellschaft während einer Veranstaltung der Evangelischen Akademie Loccum im Jahr 2021. Rivalität um Fachwissen entsteht hier dadurch, dass die Zivilgesellschaft Expert*innen beauftragen möchte, die nicht bereits in Auftragsverhältnissen zum Operator oder Regulator stehen, wodurch eine Knappheit wahrgenommen wird.

Prinzip 3 scheint zunächst erfüllt. Nicht nur betont das StandAG (§ 5 (1)) explizit die Mitgestaltungsmöglichkeit der Öffentlichkeit, die Fachkonferenz Teilgebiete sollte auch einen Raum eröffnen, in dem die Beteiligten selbst Regeln der Zusammenarbeit vereinbaren. In der weiteren Analyse ist jedoch zu betrachten, wie sich Machtwirkungen und Dominanzen von Akteuren auf das Prinzip ausgewirkt haben. Machtanalytische Betrachtungen der Fachkonferenz Teilgebiete weisen durchaus auf entsprechende Effekte hin, die die institutionelle Entwicklung der Fachkonferenz Teilgebiete beeinflusst haben (Themann, Di Nucci und Brunnengräber 2021; Themann, Schwarz et al. 2021; Schwarz et al. 2021 a, 2021 b). Auch das Forum Endlagersuche sowie die Arbeit des Planungsteam Forum Endlagersuche und deren Austausch mit der interessierten Öffentlichkeit ist vor dem Hintergrund dieses Prinzips zu reflektieren.

Ein weiteres erfülltes Prinzip, so die Hypothese, ist eine Form polyzentrischer Governance. Obwohl sie keine Entscheidungskompetenzen im Standortsuchverfahren haben, richteten einige Bundesländer oder Regionen eigeninitiativ Foren ein, um die Standortsuche zu begleiten und den Kommunen und Bürger*innen Hilfestellungen im Verfahren zu ermöglichen. So hat z. B. Niedersachsen ein ‚Begleitforum' für die Standortsuche eingerichtet. Dieses umfasst u. a. die Bereitstellung finanzieller Mittel, die Kommunen abrufen können, um etwa Gutachten in Auftrag zu geben, und so auf Fachwissen zuzugreifen. In Bayern wurde in der Region Oberfranken eine ‚Regionale Koordinierungsstelle für das Verfahren der Endlagersuche' eingerichtet. Diese Entwicklung, in der Länder, Regionen und Bürger*innen eigenständig Räume und Ressourcen schaffen, um das Verfahren kritisch zu begleiten, kann als eine Form polyzentrischer Governance interpretiert werden.

Mit Blick auf Prinzip 2 weist die Verhältnismäßigkeit der Bereitstellung und Nutzung einer selbstorganisierten Beteiligung kritische Aspekte auf, wie etwa der erhebliche zeitliche Aufwand für die ehrenamtliche Arbeitsgruppe Vorbereitung (AG V) der Fachkonferenz Teilgebiete sowie für das Planungsteam Forum Endlagersuche. Zusätzlich konstatierte das Nationale Begleitgremium eine „schleichende Zermürbung der hoch engagierten zivilgesellschaftlichen Vertreter*innen" (NBG 2022, S. 4). Grund seien mit Blick auf die Zusammenarbeit innerhalb des Planungsteam Forum Endlagersuche komplizierte Abstimmungsbedarfe im Bundesamt, die Prozesse verlangsamen sowie hierarchische Strukturen, die eigenverantwortliches Handeln behindern. Hier treffen unterschiedliche institutionelle Logiken innerhalb des Planungsteam Forum Endlagersuche aufeinander, die die Arbeit auf operativer Ebene erschweren.

Der vorläufige Ausstieg etlicher zivilgesellschaftlicher Akteure weist auf noch unausgereifte Konfliktlösungsmechanismen hin.

Prinzip 6 zu Konfliktlösungsmechanismen sowie Prinzip 7 zur Anerkennung von Selbstorganisation durch staatliche Behörden wären gemäß obiger Schilderungen wichtig für die Standortsuche, sind aber nicht erfüllt. Der vorläufige Ausstieg etlicher zivilgesellschaftlicher Akteure weist auf noch unausgereifte Konfliktlösungsmechanismen hin, obwohl durch die Rolle des Partizipationsbeauftragten (StandAG § 8 (5)) eine entsprechende Instanz bereits institutionell verankert ist. Die Beobachtungen verdeutlichen zudem, dass staatliche Akteure Vorbehalte gegenüber einer Selbstorganisation im Bereich der Beteiligung haben.

Ausblick

Erste Auswertungen des Datenmaterials aus den Beobachtungen weisen darauf hin, dass zivilgesellschaftliche Handlungen im Rahmen der Fachkonferenz Teilgebiete (§ 9) über den ‚participatory turn' (Bergmans et al. 2015) hinausweisen und eine Anwendung des Konzeptes der Commons Governance wichtige Einsichten für die Standortsuche bergen kann. Vor allem das Verständnis von einer kollektiven Verfügung über Fachwissen, der Wunsch nach anerkannter Selbstorganisation innerhalb der Beteiligungsstruktur, die sich ausbildenden polyzentrischen Strukturen sowie das Ziel der bestmöglichen Sicherheit als ein gemeinsam zu schaffendes Gut deuten auf Logiken des Commoning hin. Daneben bietet die Auseinandersetzung mit den Prinzipien aufschlussreiche Analysepunkte entlang gegenwärtiger Herausforderungen und Konflikte der Standortsuche, die in der vertieften Analyse weiter betrachtet werden sollten.

Angesichts der beschriebenen Konfliktlagen stellt sich die Frage, welche Impulse von der Commons Governance für die jetzige Situation ausgehen können. Ostrom schreibt hierzu: „In

https://doi.org/10.14512/tatup.31.3.51

jeder konkreten Situation muss aufs Neue darum gestritten werden, dass staatliche Institutionen ihrer Rolle als Treuhänder überregionaler Ressourcensysteme, als Ermöglicher für gemeingütersensitives Handeln, als Konfliktschlichter bei Nutzungskonflikten, als Unterstützer für Selbstorganisation und als aktive Förderer der Commons und der „Commoners gerecht werden" (Ostrom 2012, S. 107). Statt zu steuern, so eine mögliche Überlegung, könnte das BASE sich eher als Ermöglicher und Unterstützer einer zusätzlichen größtenteils selbstorganisierten zivilgesellschaftlichen Arena verstehen. Das Nationale Begleitgremium wiederum könnte seine ihm gesetzlich zugeschriebene Wächterfunktion ebenfalls gegenüber einer solchen Arena ausüben, um sowohl auf mögliche Fehlentwicklungen hinzuweisen als auch die Berücksichtigung der Ergebnisse durch BASE und Bundesgesellschaft für Endlagerung zu prüfen.

Mit Blick auf den langen Zeithorizont der Endlagerung erscheint es insgesamt lohnend, Organisationsformen und Governance-Konzepte zu betrachten, deren Prinzipien auf Langlebigkeit, Wissensweitergabe, Vertrauensaufbau und Adaptivität ausgelegt sind. Die Commons Governance kann hier womöglich wichtige institutionelle Impulse für den weiteren Standortsuchprozess als auch anschließende Phasen der Endlagerung setzen. Überlegungen betreffen etwa die zukünftigen Betroffenheitsräume (Steinebrunner 2021) durch den Endlagerstandort. Heute geht es um die Sicherheit als gemeinsam zu schaffendes Gut, doch je weiter das Verfahren voranschreitet und mit Errichtung des Endlagers wird die Last räumlich konzentriert und ein ‚Gemein(un)gut' oder „common pool hazard" (Stern 2011, S. 225) entsteht.

Welche Impulse die Commons Governance hier setzen kann – auch über den Fall der Endlagerung hinaus – sowie welche Ergänzungspotenziale der Fall der Standortsuche und der Blick auf öffentliche Ungüter für die Commons-Forschung bereithält, muss durch weitere Forschungsarbeiten ermittelt werden. Insbesondere im Zusammenhang mit risikoreichen Technologien und Großinfrastrukturprojekten sind auch die Verbindungslinien zwischen Risiko Governance (Renn 2008) und Commons Governance aufzuarbeiten (Stern 2011), sowie deren demokratietheoretische Implikationen.

Funding • The research presented here received funding by Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (FK 02 E 11849C), and by Lower Saxony Vorab.

Competing interests • The author declares no competing interests.

Literatur

BASE – Bundesamt für die Sicherheit der nuklearen Entsorgung (2021 a): AG L3. Selbstorganisation: Erfahrung und Perspektive. Dokumentation vom 12. 06. 2021, FKT_Bt02_029. Online verfügbar unter https://www.endlagersuche-infoplattform.de/SharedDocs/Downloads/Endlagersuche/DE/Fachkonferenz/Dok_FKT_2.Beratungstermin/FKT_Bt2_029_AG_L3.pdf?__blob=publicationFile&v=8, zuletzt geprüft am 18. 10. 2022.

BASE (2021 b): Dritter Beratungstermin der Fachkonferenz Teilgebiete. Wortprotokoll Plenum vom 06. 08. 2021. FKT_Bt3_031. Online verfügbar unter https://www.endlagersuche-infoplattform.de/SharedDocs/Downloads/Endlagersuche/DE/Fachkonferenz/Dok_FKT_3.Beratungstermin/FKT_Bt3_031_Wortprotokoll_0608.pdf?__blob=publicationFile&v=2, zuletzt geprüft am 28. 10. 2022.

BASE (2021 c): Konzept „Anschlussformat zur Fachkonferenz Teilgebiete: Fachforum Teilgebiete", beschlossen auf dem 2. Beratungstermin der Fachkonferenz Teilgebiete am 11. 06. 2021, FKT_Bt3_022. Bundesamt für die Sicherheit der nuklearen Entsorgung. Online verfügbar unter https://www.endlagersuche-infoplattform.de/SharedDocs/Downloads/Endlagersuche/DE/Fachkonferenz/Dok_FKT_3.Beratungstermin/FKT_Bt3_022_BeschlussTAG-A_Beteiligung_Transparenz.pdf?__blob=publicationFile&v=5, zuletzt geprüft am 28. 10. 2022.

Bergmans, Anne; Sundqvist, Göran; Kos, Drago; Simmons, Peter (2015): The participatory turn in radioactive waste management. Deliberation and the social–technical divide. In: Journal of Risk Research 18 (3), S. 347–363. https://doi.org/10.1080/13669877.2014.971335

Brunnengräber, Achim (2019): Ewigkeitslasten. Die „Endlagerung" radioaktiver Abfälle als soziales, politisches und wissenschaftliches Projekt. Bonn: Bundeszentrale für politische Bildung.

Brunnengräber, Achim; Mez, Lutz (2014): Strahlende Hinterlassenschaften aus Produktion und Konsumtion. Zur Politischen Ökonomie des Atommülls. In: Prokla 176, S. 371–382. https://doi.org/10.32387/prokla.v44i176.162

Di Nucci, Maria; Isidoro Losada, Ana; Themann, Dörte (2021): Confidence gap or timid trust building? The role of trust in the evolution of the nuclear waste governance in Germany. In: Journal of Risk Research, S. 1–19. https://doi.org/10.1080/13669877.2021.1936605

Euler, Johannes (2018): Conceptualizing the commons. Moving beyond the goods-based definition by introducing the social practices of commoning as vital determinant. In: Ecological Economics 143, S. 10–16. https://doi.org/10.1016/j.ecolecon.2017.06.020

Euler, Johannes (2020): Wasser als Gemeinsames. Potenziale und Probleme von Commoning bei Konflikten der Wasserbewirtschaftung. Bielefeld: transcript. https://doi.org/10.14361/9783839453766

Gaßner, Hartmut (2021): Überlegungen zur Selbstorganisation. o. O: o. V. Online verfügbar unter https://www.nationales-begleitgremium.de/SharedDocs/Downloads/DE/Downloads_54_Sitzung_10_9_2021/TOP_6_Selbstorganisation_Gassner.pdf?__blob=publicationFile&v=2, zuletzt geprüft am 28. 10. 2022.

Glaser, Barney; Strauss, Anselm (1979): Die Entdeckung gegenstandsbezogener Theorie. Eine Grundstrategie qualitativer Sozialforschung. In: Christel Hopf und Elmar Weingarten (Hg.): Qualitative Sozialforschung. Stuttgart: Klett-Cotta, S. 91–111.

Helfrich, Silke (Hg.) (2009): Wem gehört die Welt? Zur Wiederentdeckung der Gemeingüter. München: oekom.

Helfrich, Silke (Hg.) (2012): Commons. Für eine neue Politik jenseits von Markt und Staat. Bielefeld: transcript. https://doi.org/10.14361/9783839428351

Kamlage, Jan-Hendrik; Warode, Jan; Mengede, Anna (2019): Chances, challenges and choices of participation in siting a nuclear waste repository. The German case. In: Achim Brunnengräber und Maria Rosaria Di Nucci (Hg.): Conflicts, participation and acceptability in nuclear waste governance. An international comparison. Volume III. Wiesbaden: Springer Fachmedien, S. 91–110.

Kaul, Inge (2012): Rethinking public goods and global public goods. In: Eric Brousseau, Tom Dedeurwaerdere und Bernd Siebenhüner (Hg.): Reflexive governance for global public goods. Cambridge, MA: MIT Press, S. 37–53.

KLHRA – Kommission Lagerung hoch radioaktiver Abfallstoffe (2016): Abschlussbericht der Kommission Lagerung hoch radioaktiver Abfallstoffe. o. O: o. V. Online verfügbar unter https://www.bundestag.de/resource/blob/434430/bb37b21b8e1e7e049ace5db6b2f949b2/drs_268-data.pdf, zuletzt geprüft am 18. 10. 2022.

Linebaugh, Peter (2008): The Magna Carta manifesto. Liberties and commons for all. Berkeley, CA: University of California Press.

McGinnis, Michael (2011): Updated guide to IAD and the language of the Ostrom workshop. A simplified overview of a complex framework for the analysis of institutions and their development. In: Policy Studies Journal 39 (1), S. 169–183. https://doi.org/10.1111/j.1541-0072.2010.00401.x

Meretz, Stefan (2012): Ubuntu-Philosophie. Die strukturelle Gemeinschaftlichkeit der Commons. In: Silke Helfrich (Hg.): Commons. Für eine neue Politik jenseits von Markt und Staat. Bielefeld: transcript, S. 58–65.

NBG – Nationales Begleitgremium (2022): Öffentliches Fachgespräch zur Endlagersuche im Ausschuss für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz des Deutschen Bundestages am 11. Mai 2022. Berlin: Nationales Begleitgremium. Online verfügbar unter https://www.nationales-begleitgremium.de/SharedDocs/Downloads/DE/Downloads_Empfehlungen/NBG-Empfehlungen_Umweltausschuss_11_5_2022.pdf;jsessionid=33C6959435FE4181E60D49B7470B05B1.intranet242?__blob=publicationFile&v=4, zuletzt geprüft am 21. 10. 2022.

Ostrom, Elinor (2009): Gemeingütermanagement. Perspektive für bürgerschaftliches Engagement. In: Silke Helfrich (Hg.): Wem gehört die Welt? Zur Wiederentdeckung der Gemeingüter. München: oekom, S. 218–228.

Ostrom, Elinor (2012): Was mehr wird, wenn wir teilen. Vom gesellschaftlichen Wert der Gemeingüter. München: oekom.

Ostrom, Elinor (2013): Die Verfassung der Allmende. Jenseits von Staat und Markt. Tübingen: Mohr Siebeck.

Ott, Konrad (2020): Zur Einlagerung hochradioaktiver Reststoffe aus ethischer und politischer Sicht: Bestandsaufnahme und Ausblick. In: Anna Margaretha Horatschek (Hg.): Competing Knowledges – Wissen im Widerstreit. Berlin: De Gruyter, S. 171–188. https://doi.org/10.1515/9783110659658-010

Poteete, Amy; Janssen, Marco; Ostrom, Elinor (2010): Working together. Collective action, the commons, and multiple methods in practice. Princeton University Press. https://doi.org/10.1515/9781400835157

Quilligan, James (2012): Warum wir Commons von öffentlichen Gütern unterscheiden müssen. In: Silke Helfrich (Hg.): Commons. Für eine neue Politik jenseits von Markt und Staat. Bielefeld: transcript, S. 99–106.

Renn, Ortwin (2008): Risk governance. Coping with uncertainty in a complex world. London: Earthscan.

Schulz, Claudia (2016): Fonds oder Rückstellungen? Atommüll als private good und public bad. In: Achim Brunnengräber (Hg.): Problemfalle Endlager. Gesellschaftliche Herausforderungen im Umgang mit Atommüll. Baden-Baden: edition sigma, S. 261–287. https://doi.org/10.5771/9783845278131-1

Schwarz, Lucas; Themann, Dörte; Brunnengräber, Achim (2021 a): Räume erobern, öffnen und verteidigen. Über die Wirkung von Macht beim dritten Beratungstermin der Fachkonferenz Teilgebiete. In: Forschungsjournal Soziale Bewegung Plus 34 (4), S. 1–33. Online verfügbar unter https://forschungsjournal.de/hefte/2021-heft4-finanzsystem-und-zivilgesellschaft/, zuletzt geprüft am 28. 10. 2022.

Schwarz, Lucas; Themann, Dörte; Brunnengräber, Achim (2021 b): Von Machtasymmetrien zu flachen Hierarchien im Standortsuchprozess für ein Endlager? Über die Wirkung von Macht beim zweiten Beratungstermin der Fachkonferenz Teilgebiete. In: Forschungsjournal Soziale Bewegungen Plus 34 (4), S. 1–26. Online verfügbar unter https://forschungsjournal.de/hefte/2021-heft4-finanzsystem-und-zivilgesellschaft, zuletzt geprüft am 21. 10. 2022.

Steinebrunner, Martin (2021): Vom Umgang unter Nachbarn in der besten aller Welten. Nationales Begleitgremium: Gute Beteiligung? Waldshut-Tiengen: Deutsche Koordinationsstelle Schweizer Tiefenlager. Online verfügbar unter https://www.nationales-begleitgremium.de/SharedDocs/Downloads/DE/Downloads_NBG-Veranstaltung_6_11_2021/AG4_Vortrag_Steinebrunner.pdf?__blob=publicationFile&v=3, zuletzt geprüft am 21. 10. 2022.

Stern, Paul (2011): Design principles for global commons. Natural resources and emerging technologies. In: International Journal of the Commons 5 (2), S. 213–232. https://doi.org/10.18352/ijc.305

Themann, Dörte; Di Nucci, Maria; Brunnengräber, Achim (2021): Alles falsch gemacht? Machtasymmetrien in der Öffentlichkeitsbeteiligung bei der Standortsuche für ein Endlager. In: Forschungsjournal Soziale Bewegung Plus 34 (4), S. 1–10. Online verfügbar unter https://forschungsjournal.de/hefte/2021-heft4-finanzsystem-und-zivilgesellschaft, zuletzt geprüft am 21. 10. 2022.

Themann, Dörte; Schwarz, Lucas; Di Nucci, Maria; Brunnengräber, Achim (2021): Power over, power with und power to bei der Standortsuche für ein Endlager. Über die Ausübung von Macht beim ersten Beratungstermin der Fachkonferenz Teilgebiete (FKTG). In: Forschungsjournal Soziale Bewegungen Plus 34 (4), S. 1–23. Online verfügbar unter https://forschungsjournal.de/hefte/2021-heft4-finanzsystem-und-zivilgesellschaft/, zuletzt geprüft am 21. 10. 2022.

Thierbach, Cornelia; Petschick, Grit (2019): Beobachtung. In: Nina Baur und Jörg Blasius (Hg.): Handbuch Methoden der empirischen Sozialforschung. Wiesbaden: Springer Fachmedien, S. 1165–1181. https://doi.org/10.1007/978-3-658-21308-4_84

DÖRTE THEMANN
ist Politik- und Umweltwissenschaftlerin. Seit 2018 arbeitet sie als Wissenschaftliche Mitarbeiterin am Forschungszentrum für Nachhaltigkeit an der FU Berlin, Fachbereich Politik und Sozialwissenschaften. Seit 2021 promoviert sie im TRANSENS-Projekt.

https://doi.org/10.14512/tatup.31.3.51

RESEARCH ARTICLE

Human dignity and lethal autonomous weapon systems: A Christian ethical positioning from a Catholic point of view

Elmar Nass*,[1]

Abstract • This article analyses the ethical debate over the use of lethal autonomous weapon systems (LAWS) by exploring, from a Catholic perspective, how Christian ethics can position itself in this discussion. Since humanity will not be able to avoid wars in the future, ideas of justified use of armed force (in self-defense), but also of appropriateness of defensive weapon systems, remain important issues. Based on the so-called 'protection rationale,' proponents hold that autonomous weapon systems (AWS) can shield one's own forces while reducing the damage inflicted upon the enemy. Opponents seek to ban AWS categorically, especially LAWS. The moral dilemmas and ethical dimensions involved make LAWS a genuine subject for technology assessment in terms of the technology's consequences for humanity, dignity, and coexistence.

Menschenwürde und tödliche autonome Waffensysteme:
Eine christlich-ethische Positionierung aus katholischer Sicht

Zusammenfassung • *Dieser Artikel analysiert die ethische Debatte um den Einsatz tödlicher autonomer Waffensysteme (LAWS), indem er aus einer katholischen Perspektive der Frage untersucht, wie sich eine christliche Ethik in dieser Diskussion positionieren kann. Da sich Kriege auch in Zukunft nicht vermeiden lassen werden, bleiben Vorstellungen über den gerechtfertigten Einsatz von Waffengewalt (zur Selbstverteidigung), aber auch über die Angemessenheit defensiver Waffensysteme wichtige Themen. Basierend auf der sogenannten ‚Schutzbegründung' vertreten die Befürworter die Auffassung, dass autonome Waffensysteme (AWS) die eigenen Streitkräfte schützen und gleichzeitig den Schaden beim Feind verringern können. Opponenten wollen AWS kategorisch verbieten, insbesondere LAWS. Die damit verbundenen moralischen Dilemmata und ethischen Dimensionen machen LAWS zu einem genuinen Gegenstand der Technikfolgenabschätzung im Hinblick auf die Folgen der Technik für Menschlichkeit, Würde und Zusammenleben.*

Keywords • *acceptability, meaningful human control, lethal autonomous weapon systems, human-machine relationship*

Ethical technology assessment

Questions surrounding the legitimate use of so-called lethal autonomous weapon systems (LAWS) are becoming increasingly topical due to new threat situations in Europe and must be the subject of in-depth ethical dialogue in light of numerous normative concerns. This article therefore explores a Christian position, not covered in this way until now, and compares it with some ethical arguments already discussed so far. For this the question of the justification of war (*jus ad bellum*) is less important than the question of the *'jus in bello'*: the ethical technology assessment on the use of LAWS for all those involved (users of the systems as well as affected combatants and non-combatants).

On the question of justified war, there is a wealth of discussion among Christians. From the Catholic vantage point, in this discussion it is possible to refer not only to the provisions of international law, which naturally must be observed, but also to the relevant doctrine of the so-called *'bellum iustum'*. According to this view, forcible defense (but never a war of aggression) is also ethically legitimate under strict conditions (Nass 2020, pp. 171–179). The Pontifical Council for Justice and Peace (2006, No. 2309) mentions these conditions: "the damage inflicted by the aggressor on the nation or community of nations must be lasting, grave, and certain; all other means of putting an end to it must have been shown to be impractical or ineffec-

* *Corresponding author: elmar.nass@khkt.de*
[1] *Lehrstuhl für Christliche Sozialwissenschaften und gesellschaftlicher Dialog, Kölner Hochschule für Katholische Theologie, Cologne, DE*

https://doi.org/10.14512/tatup.31.3.58
Recieved: Apr. 25, 2022; revised version accepted Sep. 26, 2022;
published online: Dec. 16, 2022 (peer review)

tive; there must be serious prospects of success; the use of arms must not produce evils and disorders graver than the evil to be eliminated". However, this doctrine is disputed among Christians, for example by the Anglican theologian N. Biggar (2013). In order not to adopt such divergent positions, this article is intended as an introductory Catholic perspective. When I speak in the following of profiling a Christian positioning, I am referring to the Catholic variant.

The article will focus on the *'jus in bello'*: Christian arguments on the question of the justified use of LAWS have not been profiled so far. This article aims to fill this gap with regard to the ethical consequences for the understanding of dignity, humanity and coexistence of all persons involved. Important to *'jus in bello'* is the distinction that combatants, as opposed to non-combatants, may be intentionally killed. Under the *Doctrine of Double Effect*, unintentional killings of the latter may also be legitimized. The ethical discussion here recognizes this distinction and now focuses on the question of LAWS as legitimate means, basing the thesis in that the "how" of killing affects human dignity, even beyond the question of who is killed. The Pontifical Council has expressly called for such a critical review of relevant weapon systems. Of course, certain lethal weapons, such as cluster bombs, chemical or biological weapons, are categorically banned. Should this also apply to the use of LAWS? To answer this question, it is first necessary to clarify what constitutes these systems and their use. This is followed by an overview of the ethical arguments put forward thus far. The article concludes by presenting a Christian position on the use of LAWS, thereby profiling it as a dialogue partner for the discussions surrounding this ethical technology assessment.

The nature and use of LAWS

The focus of the following discussion is not on a differentiation between supposedly good or evil technology, but on the normatively assessable consequences of their technical use for people, their decisions and their responsibility for the respective consequences. Here we see this discussion being assigned to the area of technology assessment. What is not discussed here is the use of autonomous weapon systems for defense against missiles ('Sense and React to Military Objects' – SARMO) for non-lethal strategic use under water or in terrain inaccessible to humans, etc. (Amoroso et al. 2018). The ethical evaluation of the use of such non-lethal systems is another topic.

So now to the question of what LAWS actually are. The concept of autonomy in the denomination allows many interpretations. In the deontological sense of a Kantian philosophy, autonomy means compliance with given duties that is freed from selfish interests. This interpretation suggests human or at least human-like reasoning processes. In the information technology sense, autonomy can be understood as independence from human intervention. As defined by the US Department of Defense, an autonomous weapon system (AWS) is "a weapon system that, once activated, can select and engage targets without further intervention by a human operator" (United States Department of Defense 2012, p. 13 cited in Koch 2019, p. 30). Such systems go far beyond what we are currently already seeing in the use of remotely piloted combat drones (Koch and Rinke 2018; Horowitz 2016). AWS are commonly understood as highly automated weapon systems that are independent of human decisions in terms of command and control (human out of the loop). This distinguishes them from non-autonomous or semi-autonomous systems, where humans have either full or partial command and control (human in/on the loop) (Franke 2016). LAWS thus belong to the realm of digital technology 4.0, which can control and correct itself without human influence. According to Noel Sharkey the degree of 'autonomy' can be distinguished in five different levels (L1 to L5). These levels represent a decreasing possibility of human intervention (Amoroso and Tamburrini 2020; Sharkey 2016). L1 to L4 denote semi-autonomous, L5 fully autonomous systems (human out of the loop):

- L1: A human engages with and selects targets and initiates any attack.
- L2: A program suggests alternative targets, and a human chooses which to attack.
- L3: A program selects targets, and a human must approve them before the attack.
- L4: A program selects and engages targets without any further confirmation, but a human can abort the attack.
- L5: A human merely programs the primary goal of the mission. The program then acts within this framework (box) without further human intervention. Boxing means the programmed definition of the subsequently autonomous weapon deployment of the LAWS.

When using the semi-autonomous systems from L1 to L4, in addition to the programmers, there are also soldiers as supervisors who can still intervene in an ongoing military operation. When

Highly automated weapon systems are independent of human decisions in terms of command and control (human out of the loop).

https://doi.org/10.14512/tatup.31.3.58

using the fully autonomous systems (L5), there is no supervision, only the programmer. I consider supervisors and programmers together as the immediate LAWS-using staff (LUS) in the following ethical discussions.

The following normative questions must now be answered as differentiations of the initial question: Should such weapon systems, considering their consequences for people, decision-making and responsibility, be categorically banned? If not, then: Which level of human supervision is ethically acceptable? (L1-L4). Can L5 (human out of the loop) also be justified from a Christian point of view? To answer these questions, some of the ethical arguments already discussed will now be presented before examining them from a Christian perspective.

The ethical debate on the deployment of LAWS: a survey

Some essential arguments for and against the use of LAWS will now be weighed. The so-called 'protection rationale' speaks in favor of the use of LAWS because the use of such systems spares human life in the ranks of one's own forces, which can now be replaced by fighting machines (Koch 2019, p. 22). But, of course, this does not spare the lives of the enemy. Strategic targets can be destroyed with pinpoint accuracy in the conduct of war, which could help reduce the overall scale of war-related destruction. At the same time, however, it is also possible to focus on additional targets such as these, which can quickly neutralize or even reverse the anticipated destructive impact (including the number of casualties) (Koch and Rinke 2018, p. 42). Nevertheless, it must be noted here that it is the inherent nature of war to strike one's opponent heavily enough to exact defeat. This is hardly achievable without some level of destruction.

The higher the degree of so-called 'autonomy', the more the LUS is spared from potentially traumatizing images of destruction and killing. This could also be seen as an advantage in favor of the use of LAWS. However, this method of sparing can reduce the LUS' awareness of the destructive consequences and thus lower the inhibition threshold for violence, with the danger of increasing cruelty and even mass destruction in warfare. This goes hand in hand with the expressed concern about an increasing anonymization of the act of killing and a reification of the casualties, as if the LUS is merely sitting in front of a computer game with virtual combatants (Koch 2019, p. 35). However, hand-to-hand combat on the battlefield, where combatants are directly confronted with the consequences of their own actions, has long been a thing of the past. Every torpedo or missile launched already carries an inherent risk of desensitization.

The increased risk of hacker attacks on LAWS cannot be dismissed and must therefore be taken very seriously (Koch 2019, p. 27). However, this also applies to other central defense systems, such as communications or radar systems. This argument calls for particular vigilance but is not sufficient to demand that such weapon systems be categorically banned.

Following deontological questions such as the consequences for humanity and responsibility, the use of LAWS means potential violations of human dignity. These potential violations of human dignity affect 1.) primarily the victims who lose their lives through the use of LAWS, but 2.) also the LUS:

1. As levels increase, but especially starting with a variant of L5, for example, the destruction of human life becomes a plaything of algorithms (Rosert and Sauer 2019, p. 373). People who are killed are no more than points in the crosshairs to be destroyed. This problem – as already shown – also exists with other systems. Now, however, lethal destruction is carried out by self-governing algorithms, whose actions can no longer be stopped. This degree of 'autonomy' places human life at the disposal of uncontrollable computational operations (Birnbacher 2016). The violation of human dignity (the killing of human beings) in dilemma situations made on the basis of a human 'ultima ratio' decision is now removed from human decision-making. However, violating inviolability can only be legitimized if the decision to do so itself consciously considers this inviolability and is aware of the evil involved (Heyns 2013, p. 17). But in the use of L5-LAWS now such reflection can no longer take place.
2. What's more, in this constellation programmers ultimately become slaves to the LAWS, because it is no longer possible to intervene in individual system operations (Amoroso and Tamburrini 2020, p. 188). The machine rules over the persons who programmed LAWS and who can no longer put a stop to the technology, e.g. in unforeseen situations that require reassessment. LAWS replace human agency with artificial agency in their lethal use (Leveringhaus 2016). Part of the dignity of free individuals is making decisions for which they take responsibility. But if precisely this freedom is taken away and they may only stand idly by and watch what the autonomous system does, they are its slaves. Contrary to Immanuel Kant's categorical imperative on human dignity, we now also see an instrumentalization of the system's programmers alongside the (already egregious) instrumentalization of its victims. And not by people, but by technical arrangement, which makes it even more serious. Here one might conclude that the use of such systems is intrinsically bad (an *intrinsece malum*), which would justify a categorical ban.

This demand is supported by the question of who takes responsibility in case of mistakes (which come at the cost of human lives, inflict excessive damage and could even constitute war crimes) (Koch 2019, p. 33). It cannot be the supervisor. He has no influence on the autonomous areas of the LAWS on L1 to L4. It can hardly be the system's manufacturer. Perhaps the programmer must certainly have reckoned with any associated mistakes or crimes. But, as we have just seen, these LAWS-programming persons are deprived of their freedom to intervene after the initial activation. It seems quite unreasonable to hold the programmer accountable for unforeseeable errors or sudden changes in

the combat situation that would have required initial boxing at a different level. Or should it then simply be the system itself that must be held accountable and bear the consequences – akin to some humanoid being (Matsuzaki and Lindemann 2016)? Following Sparrow (2007), it is impossible to find a satisfactory answer to the question of who should bear the responsibility. So, when no responsible human can be found for the war crimes of robots, with Sparrow this also speaks in favor of a categorical ban of LAWS. Leveringhaus (2016), unlike Sparrow, denies this responsibility gap and sees the programmer of L5 as responsible because, after all, he should be able to anticipate the corresponding consequences. In the end, however, he also calls for a ban on L5 based on this insight.

Furthermore, consequences of the use of LAWS for the nature of warfare are considered ethically questionable. International law, for instance, is easily violated when borders are breached, and human emotions such as compassion or humanitarian aid for wounded opponents could be reduced or eliminated altogether (Amoroso and Tamburrini 2020, p. 188). The same applies to the life-saving alternative of capturing opponents instead of killing them. Such consequences violate the so-called Martens Clause, which states that civilian and combatant lives in war are subject to respect for principles of conscience and humanity that a self-directed weapon system cannot fulfill (United Nations 2001, Preamble). Arkin (2008) counters by pointing out that negative human emotions (anger, hatred, etc.) are responsible for many war crimes that could have been prevented by using AWS. He proposes the integration of a moral algorithm (as an 'ethical governor'), which is integrated as a 'conscience' into the AWS. This governor should be programmed on the basis of experience through the participation of seasoned ethicists. It should contain elements of utilitarian and deontological ethics with the deliberative equilibrium of John Rawls as a pragmatic ethics mix of case-based reasoning, which does not consistently follow the rationale of one particular ethical logic (Arkin et al. 2009). This self-learning ethical algorithm should be continually advanced by feeding in proven decisions in concrete combat situations. The ethical governor is thus intended to provide quasi-evidence-based, ethically responsible control of the LAWS. Arkin (2015) suggests such an arrangement to make particularly humanitarian decisions based on ethical deliberation. So, in the end, with the programmed conscience, are LAWS (even on L5) the more humane killing machines? Then, of course, they would not only have to be permitted, but their use would have to be encouraged.

Based on some available ethical arguments, the main concerns surrounding the use of LAWS come into focus: Legitimizing the greatest possible autonomy forces a relativization of human dignity, leaves the question of legal and moral responsibility largely unanswered and accelerates a virtue-ethical desensitization that could have an effect not only in war but also quite fundamentally in the culture of human coexistence (brutalization). This suggests a ban. Besides the 'protection rationale', Arkin's arguments in particular, on the other hand, argue in favor of using LAWS as a weapon system worthy of preference over alternative ones, provided that ethics are programmed into LAWS.

A Christian-based assessment

Value compass

This article now explores the main ethical challenges from a Christian perspective. First, we must briefly outline the essential content of a suitable Christian value compass as a test criterion for the ethical acceptability of the use of LAWS.

The essential basis of Christian ethics is the foundation of inviolable human dignity in the image of God in every human being (Nass 2020, pp. 25–73). Killing another human being is therefore always evil, even if it can be justified as an 'ultima ratio'. Being made in God's image, this elevated dignity belongs to humankind alone. Technology is always merely an instrument designed to serve humanity and its fulfillment in responsibility before the creator and before itself. It is meant to serve humankind to live a life that can ultimately be considered good (i. e. in life after earthly death) before a merciful God. The instrumentalization of human beings by technology is categorically illegitimate, as is the dilution of human dignity by assigning quasi moral and other human attributes to technical artifacts.

The instrumentalization of human beings by technology is categorically illegitimate.

Human freedom is always conceived in love for and in responsibility before the Creator God, before oneself in His image and before one's fellow human beings. The assumption of responsibility is an expression of human freedom and a moral compass for a good life in this threefold orientation. This applies to one's individual way of life (including the necessary virtues of faith, hope and love) as well as to the culture of an irenic-inclusive coexistence of people. After all, from the Christian perspective, all humans are made in God's image – including strangers or enemies – but not technical artifacts. This is why Christian ethics also forbids an exclusive hybrid of race, class, nationality, religion or the like that seeks to divide society. A society is good and thus ethically legitimate when it enables as many people as possible to develop and grow in freedom and responsibility in accordance with their abilities.

https://doi.org/10.14512/tatup.31.3.58

We can now in view of the essential arguments use this compass to make some specific distinctions regarding the question of whether to categorically ban LAWS, so that we may explore a Christian positioning.

A justified examination

A corresponding position on the question of a legitimate use or prohibition of LAWS will now be outlined on the basis of the Christian understanding of human dignity, coexistence and just war. This is not to claim that the Christian position represented here itself generates entirely new arguments. Rather, the main aim is to identify a calibrated compass from a Christian perspective in the complex discussion and to bring it as a coherent position into further discussions.

1. The highest level of Meaningful Human Control (MHC) must be sought based on the Christian imperative of threefold responsibility. It should be noted that, from a Christian viewpoint, the killing of any human being and, by extension, death caused by the corresponding use of weapons, is considered evil. As a result, there are no good weapons and there is no good way to use weapons. Violations of dignity must be justified (on equal footing) at the level of the argument of dignity. Such conditions for a legitimate use of force with weapons are, after all, formulated by Catholic social teaching with the principles outlined at the beginning of this article, which correspond to the theory of just war. Only in compliance with these conditions can violence and war be excused or justified in the first place.
2. Following 1.) the Christian idea of an ethics that is not relativistic, but based on unconditional values, 2.) the ethical narratives of Michael Sandel (2012), according to which there are values that money cannot buy (e.g. friendship, the Nobel Prize) or replace with technology (e.g. human feelings such as love), and 3.) the warnings against an idolization of market and technology (Pope Francis 2015), we must seek to uncover slippery slopes and red lines and define what we would want to do with technical systems – bearing in mind responsibility for human dignity and social culture – and what we would not want to do, even if we could. Even taking into account Arkin's own concerns about the ethical consistency of his 'ethical governor' in LAWS on L5, I consider the use of such a 'governor' may produce ethically sound results. But a Christian position cannot follow Arkin's interpretation here. On the one hand, Arkin, Ulam and Duncam (2009) emphasize with McLaren (2006) that ultimate moral responsibility in the use of LAWS always attaches to humans after all. On the other hand, the supposed humanoid ethical evidence is still far too indeterminate in content. Arkin, Ulam and Duncam (2009) also acknowledge this ethically relevant research desideratum. Christian ethics cannot share the view that computational operations based on algorithms have anything to do with ethical deliberation. This hypothesis undermines the content of human dignity by making a moral distinction between humans and machines impossible (Nida-Rümelin and Weidenfeld 2018).
3. The intentional killing of a human being is always a violation of dignity. Accordingly, the *'jus in bello'* only combatants may be intentionally killed. If all these conditions are fulfilled, the further question arises whether the means used for this violation of dignity nullify this justification. Such an abrogation of justification is present on L 5. The reason for this is another dignity violation. This violation consists mainly in the fact that human life becomes a plaything of algorithms (see the common dignity arguments above).
4. The concerns regarding human dignity extend to other areas of society as well. Comparable questions arise, for example, in discussions concerning the use of (humanoid) robotics 4.0 in production and healthcare (Nass and Schneider 2022). In these areas, humans (e.g., doctors or nurses) will likewise soon be replaced by robots with supposed artificial intelligence and artificial morality, and possibly subordinated to them and their commands. We have thus reached an entirely new stage based on the fact that with LAWS such subordination of humans is also connected to the violent killing of other human beings, which is hardly an issue, if at all, when it comes to the use of robots in healthcare. Beyond the arguments of Arkin et al. it could even be the top rung on a ladder leading to dehumanization.
5. Simply banning all LAWS is inappropriate. The Christian value compass requires a differentiated view: Thus, because of the already mentioned violations of the human dignity of the enemy (as God's likeness), the enslavement of the LUS and the curtailment of the threefold human responsibility, LAWS should be outlawed at L5. The semi-autonomous systems at levels below L5, however, still allow responsible human intervention (human on/in the loop). They can avoid a categorical ban based on Christian thinking if LUS are entrusted with decisions on the use of LAWS, receive education and training not only in law, but also in morality and virtue, these soldiers are made aware of the inviolable dignity of their counterparts (while respecting the command to love one's enemy) and they are conscious of their responsibility before humanitarian principles. The risk of desensitization

It is wise not to ascribe a quasi-artificial morality to weapon systems.

 https://doi.org/10.14512/tatup.31.3.58

must be countered through appropriate ethical training. This is a possible way to make users conscious of guilt, which from a Christian perspective is indispensable even when the use of weapons is justified. Curricula of such ethical education should include e.g. content on the ethics of responsibility and ethics of mind, on the formation of conscience and judgment, on images of man and their consequences for the understanding of human dignity and on the concrete lethal effects of the use of LAWS, based on specific case studies (Vohs 2021). Professional training departments of the military chaplaincy or comparable institutes of different ideological or religious persuasions could be involved in the development of teaching content. Defining the specifics of such curricula would then be a next important step for an ethically acceptable use of LAWS on L1-L4.

6. The UN Human Rights Council could formulate international educational standards. These guidelines would then need to be concretized in the respective countries, but should undergo appropriate reviews. This would allow us to counteract the brutalization of agents and societies, which would go against everything we consider conducive to the development of humankind before God and the inclusive idea of coexistence. If it is impossible to ensure this education and training in morality and virtue (in totalitarian states, for instance), then the use of LAWS should ethically be prohibited in these countries. Such an ethical ban could be imposed by the UN Council on Human Rights. However, this critical distinction hardly seems practicable in the real world. If countries such as China in an effort to create threatening scenarios or attackers in a war of aggression refuse to acknowledge such educational standards, they will likely still deploy such weapon systems in an immoral and unvirtuous fashion. Thus, realistically, the UN reaction would admittedly be no more than a moral rebuke. But from a Christian point of view even this stigmatization would at least be an important step towards the protection of human dignity.

Conclusion

The arguments in the ethical debate on the possible use of LAWS address central concerns about our view of humanity, humankind, the human-machine relationship and human responsibility. Christian explorations indicate red lines with sound reasoning and follow the arguments for a partial ban on such systems (L5), along with strict provisions for conditional approval. Above all, the Christian position insists on the awareness that even any justified defense with these systems ultimately always has devastating consequences. It is therefore never good in itself, but can at best be tolerated as *'minus malum'*. Christian ethics includes in the discussion of human dignity not only the victims of LAWS, but also the LUS. It also advocates a virtue ethics offensive for the ethical education of soldiers who are directly involved with such weapons systems. For morality understood in Christian terms is not found in machines, nor in rules alone. It is ultimately rooted in the consciences of bona fide humans.

The Christian position presented here has one more semantic consequence: From a Christian point of view it is wise not to ascribe a quasi-artificial morality to weapon systems with a 'decision-making capability' attributed to them. I propose to avoid the common attribution 'autonomous' in the context of technology in general and LAWS in particular, and replace it, for example with: 'self-directed weapon systems'.

The Christian ethical positioning presented here from a Catholic perspective is no more than a brief sketch. It is aimed at offering initial arguments in favor of Christian-based participation in the ethical discourse on LAWS. This requires further development of these arguments along with enrichment through alternative Christian positions, which are welcome to engage in further constructive dialogue.

Funding • This work received no external funding.
Competing interests • The author declares no competing interests.

References

Amoroso, Daniele; Sauer, Frank; Sharkey, Noel; Suchman, Lucy; Tamburrini, Guglielmo (2018): Autonomy in weapon systems. The military application of Artificial Intelligence as a litmus test for Germany's new foreign and security policy. Berlin: Heinrich Böll Stiftung. Available online at https://www.boell.de/sites/default/files/boell_autonomy-in-weapon-systems_1.pdf, last accessed on 21. 09. 2022.

Amoroso, Daniele; Tamburrini, Guglielmo (2020): Autonomous weapons systems and meaningful human control. Ethical and legal issues. In: Current Robo-ethics Reports 1, pp. 187–194. https://doi.org/10.1007/s43154-020-00024-3

Arkin, Ronald (2015): The case for banning killer robots. Counterpoint. In: Communications of the ACM 58 (12), pp. 46–47. https://doi.org/10.1145/2835965

Arkin, Ronald (2008): Governing lethal behavior. Embedding ethics in a hybrid deliberative/reactive robot architecture. Part I. Motivation and philosophy. In: Proceedings of the 3rd ACM/IEEE international conference on Human robot interaction. New York: Association for Computing Machinery, pp. 121–128. https://doi.org/10.1145/1349822.1349839

Arkin, Ronald; Ulam, Patrick; Duncan, Brittany (2009): An ethical governor for constraining lethal action in an autonomous system. In: CSE Technical reports 163. Available online at https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1166&context=csetechreports, last accessed on 21. 09. 2022.

Biggar, Nigel (2013): In defence of war. Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199672615.001.0001

Birnbacher, Dieter (2016): Are autonomous weapons systems a threat to human dignity? In: Nehal Bhuta, Susanne Beck, Robin Geiß, in-Yan Liu und Claus Kreß (eds.): Autonomous Weapons Systems. Law, Ethics, Policy. Cambridge, U.K.: Cambridge University Press, pp. 105–121. https://doi.org/10.1017/CBO9781316597873.005

Franke, Ulrike (2016): Automatisierte und autonome Systeme in der Militär- und Waffentechnik. In: Aus Politik und Zeitgeschichte 66 (35–36), pp. 28–32. Available online at https://www.bpb.de/shop/zeitschriften/apuz/232968/automatisierte-und-autonome-systeme-in-der-militaer-und-waffentechnik/, last accessed on 21. 09. 2022.

Heyns, Christof (2013): Report by the special rapporteur on extrajudicial, summary or arbitrary executions. Annual Report Human Rights Council A/HRC/23/47. Geneva: Human Rights Council. Available online at https://www.ohchr.org/sites/default/files/Documents/HRBodies/HRCouncil/RegularSession/Session23/A-HRC-23-47_en.pdf, last accessed on 21. 09. 2022.

Horowitz, Michael (2016): The ethics and morality of robotic warfare. Assessing the debate over autonomous weapons. In: Daedalus 145 (4), pp. 25–36. https://doi.org/10.1162/DAED_a_00409

Koch, Bernhard (2019): Die ethische Debatte um den Einsatz von ferngesteuerten und autonomen Waffensystemen. In: Ines Werkner and Marco Hofheinz (eds.): Unbemannte Waffen und ihre ethische Legitimierung. Gerechter Frieden. Wiesbaden: Springer VS. https://doi.org/10.1007/978-3-658-26947-0_2

Koch, Bernhard; Rinke, Bernhard (2018): Der militärische Einsatz bewaffneter Drohnen. Zwischen Schutz für Soldaten und gezieltem Töten. In: TATuP – Journal for Technology Assessment in Theory and Practice 27 (3), pp. 38–44. https://doi.org/10.14512/tatup.27.3.38

Leveringhaus, Alex (2016): What's so bad about killer robots? In: Journal of Applied Philosophy 35 (2), pp. 341–358. https://doi.org/10.1111/japp.12200

Matsuzaki, Hironori; Lindemann, Gesa (2016): The autonomy-safety-paradox of service robotics in Europe and Japan. A comparative analysis. In: AI & Society 31, pp. 501–517. https://doi.org/10.1007/s00146-015-0630-7

McLaren, Bruce (2006): Computational models of ethical reasoning. Challenges, initial steps, and future directions. In: IEEE Intelligent Systems 21 (4), pp. 29–37. https://doi.org/10.1109/MIS.2006.67

Nass, Elmar (2020): Christliche Sozialethik. Orientierung, die Menschen (wieder) gewinnt. Stuttgart: Kohlhammer.

Nass, Elmar; Schneider, Michael (2022): Maschinen mit Moral für eine gute Pflege der Zukunft. In: Mario Pfannstiel (ed.): Künstliche Intelligenz im Gesundheitswesen. Entwicklungen, Beispiele und Perspektiven. Springer: Berlin, pp. 311–323. https://doi.org/10.1007/978-3-658-33597-7_13

Nida-Rümelin, Julian; Weidenfeld, Nathalie (2018): Digitaler Humanismus. Eine Ethik für das Zeitalter der Künstlichen Intelligenz. München: Piper.

Pontifical Council of Justice and Peace (ed.) (2006): Compendium of the social doctrine of the church. London: Burns and Oates. Available online at http://www.vatican.va/roman_curia/pontifical_councils/justpeace/documents/rc_pc_justpeace_doc_20060526_compendio-dott-soc_en.html, last accessed on 21. 09. 2022.

Pope Francis (2015): Encyclical letter Laudato Sí of the Holy Father Francis on care for our common home. Vatican City: Vatican Press. Available online at https://www.vatican.va/content/dam/francesco/pdf/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si_en.pdf, last accessed on 22. 09. 2022.

Rosert, Elvira; Sauer, Frank (2019): Prohibiting autonomous weapons. Put human dignity first. In: Global Policy 10 (3), pp. 370–375. https://doi.org/10.1111/1758-5899.12691

Sandel, Michael (2012): What money can't buy. New York: Farrar, Straus and Giroux.

Sharkey, Noel (2016): Staying in the loop. Human supervisory control of weapons. In: Nehal Bhuta, Susanne Beck, Robin Geiß, Hin-Yan Liu and Claus Kreß (eds.): Autonomous weapons systems. Law, ethics, policy. Cambridge, U.K.: Cambridge University Press, pp. 23–38. https://doi.org/10.1017/CBO9781316597873.002

Sparrow, Rob (2007): Killer robots. In: Journal of Applied Philosophy 24 (1), pp. 62–77. https://doi.org/10.1111/j.1468-5930.2007.00346.x

United Nations (2001): Convention on prohibitions or restrictions on the use of certain conventional weapons which may be deemed to be excessively injurious or to have indiscriminate effects as amended on 21 December 2001. Geneva: United Nations. Available online at https://geneva-s3.unoda.org/static-unoda-site/pages/templates/the-convention-on-certain-conventional-weapons/CCW%2Btext.pdf, last accessed on 21. 09. 2022.

United States of America Department of Defense (2012): Directive No. 3000.09. Autonomy in weapon systems. s.l.: s.n. Available online at https://www.esd.whs.mil/portals/54/documents/dd/issuances/dodd/300009p.pdf, last accessed on 21. 09. 2022.

Vohs, Vanessa (2021): Meaningful human agency in automated weapon systems. A plea for human-in-the-loop regulation. In: LSE Law Review Blog. Available online at https://blog.lselawreview.com/2021/10/meaningful-human-agency-automated-weapon-systems-plea-human-in-the-loop-regulation, last accessed on 21. 09. 2022.

PROF. DR. DR. HABIL. ELMAR NASS
is a Catholic priest with a background in finance and, since 2021, holder of the Chair of Christian Social Sciences and Social Dialogue at the Cologne University of Catholic Theology. His research concentrates on economic, social, technological ethics, social market economy, and Christian ethics in the dialogues of our time.

RESEARCH ARTICLE

Analyse der sozialen Folgen von digitalen Technologien für Betriebe in der kleinstrukturierten Landwirtschaft

Sara Anna Pfaff*[,1], Angelika Thomas[1], Andrea Knierim[2]

Zusammenfassung • Bisher liegen nur wenige Erkenntnisse hinsichtlich der sozialen Folgen von digitalen Technologien für den Arbeitsalltag in der kleinstrukturierten Landwirtschaft vor. Gleichzeitig haben Landwirte oft wenig Informationen, um abschätzen zu können, was sie nach einer Investition in digitale Technologien erwartet. Informationen über Investitionsfolgen sind jedoch nötig, um Landwirte gezielt zu unterstützen und die Akzeptanz zu erhöhen. Der vorliegende Beitrag untersucht die möglichen Folgen am Beispiel Baden-Württembergs mithilfe der Vorgehensweise der Technikfolgenabschätzung. Die Basis hierfür bilden 38 qualitative Experteninterviews, welche qualitativ und inhaltlich analysiert wurden. Die Ergebnisse zeigen technologiespezifische soziale Folgen v. a. für Arbeit und Familie sowie Lösungsansätze für die (Familien-)Betriebe in der kleinstrukturierten Landwirtschaft auf. Daraus resultieren Hinweise für Industrie, Handel, Politik, Bildung und Beratung.

Analysis of social consequences of digital technologies for farms in small-scale agriculture

Abstract • *So far, only few results are available regarding the social consequences of digital technologies for everyday work in small-scale agriculture. At the same time, farmers often have little information to assess what to expect after investing in digital technologies. However, information on possible consequences becomes more and more relevant to support farmers in a targeted way and to increase acceptance. This article examines the possible consequences using the technology assessment approach, taking Baden-Württemberg as an example. For this purpose, we conducted 38 qualitative expert interviews and analyzed them qualitatively and content-wise. The results show technology-specific social consequences (e.g. for work, family) and possible solutions for (family) farms in small scale agriculture. They provide useful information for industry, trade, politics, education, and consulting.*

Keywords • *digitalization, small-scale agriculture, social impacts, technology assessment, daily work*

Einleitung

Die Digitalisierung ist in nahezu jeder Branche spürbar, dies gilt auch für die Landwirtschaft. Digitale Technologien in der Landwirtschaft sind vielfältig, lassen sich aber wie folgt in zwei Gruppen gliedern: (1) softwarebasierte Technologien (z. B. *Farm Management Information* Systeme, Apps) und (2) physische Technologien (z. B. Anbaugeräte am Traktor, automatische Lenksysteme, Sensoren) (Birner et al. 2021). In Betrieben in der kleinstrukturierten Landwirtschaft werden digitale Technologien teilweise zögerlich genutzt (Gabriel und Gandorfer 2020). Kleinstrukturierte Landwirtschaft steht im vorliegenden Beitrag für eine Agrarstruktur, welche im Vergleich mit anderen Agrarregionen Deutschlands durch eine geringe betriebliche Flächenausstattung, einen hohen Anteil an Familienarbeitskräften und Familienbetrieben, geringe Schlaggrößen und/oder heterogene Schlagformen, einen geringen Spezialisierungsgrad sowie einen hohen Anteil an Sonderkulturanbau geprägt ist. Baden-Württemberg zeichnet sich durch diese Agrarstruktur aus (Stala 2021). Aufgrund vielfältiger Studien zu Innovationsprozessen in der Landwirtschaft lässt sich annehmen, dass erwartete oder bereits erlebte soziale Folgen den Übernahmeprozess der Landwirte von Innovationen beeinflussen (Rogers 2003). Angelehnt an Rogers (2003) werden in dieser Studie soziale Folgen als direkte oder indirekte sowie erwünschte und unerwartete Veränderungen für

* *Corresponding author: sara.pfaff@hfwu.de*
[1] *Institut für Angewandte Agrarforschung, Hochschule für Wirtschaft und Umwelt Nürtingen-Geislingen, Nürtingen, DE*
[2] *Fachgebiet Kommunikation und Beratung in ländlichen Räumen, Universität Hohenheim, Stuttgart, DE*

https://doi.org/10.14512/tatup.31.3.65
Recieved: Apr. 22, 2022; revised version accepted: Sep. 07, 2022;
published online: Dec. 16, 2022 (peer review)

Landwirte sowie für deren innerbetriebliches soziales Umfeld (das heißt Familienmitglieder, Arbeitskräfte) definiert.[1]

Bisher sind für Landwirte in kleinen Strukturen keine umfassenden Informationen über den Einstieg in die Nutzung und die Auswirkungen von digitalen Technologien verfügbar (Cisternas et al. 2020). Ohne ausreichende Informationen fehlen den Landwirten Entscheidungsgrundlagen, um Alternativen, Konsequenzen und Risiken für sich einschätzen zu können. Mögliche Auswirkungen der Digitalisierung auf den Arbeitsalltag sowie die innerbetriebliche Zusammenarbeit sind bislang nur teilweise wissenschaftlich untersucht (z. B. Zscheischler et al. 2022). Zu den relativ intensiv betrachteten Technologien gehört z. B. der Melkroboter (Schewe und Stuart 2015; Goller et al. 2021). Die bisherigen Erkenntnisse der Forschung zur Auswirkung der Digitalisierung werden nachfolgend kurz erläutert.

Durch einen veränderten Wissens- und Kompetenzbedarf steigt der Bedarf an qualifizierten Facharbeitskräften (Sparrow und Howard 2021; Zscheischler et al. 2022), dies steht dem aktuellen Facharbeitskräftemangel gegenüber (Borges et al. 2017). Positive Effekte durch den Einsatz von Robotik werden in der Steigerung der Familien- und Freizeitaktivität (Sparrow und Howard 2021), der Flexibilisierung der Arbeit sowie der körperlichen Entlastung (Rohleder et al. 2020) festgestellt. In einer Fallstudie bezüglich der Nutzung von Melkrobotern im Norden Deutschlands bestätigen Goller et al. (2021) die genannten positiven Effekte. Gleichzeitig zeigen sie, dass Landwirte den Druck durch die ständige Erreichbarkeit und externe (Service-)Abhängigkeit negativ wahrnehmen. Auswirkungen durch die Nutzung sind zudem betriebsindividuell, lassen sich nicht vereinheitlichen und werden z. B. von der Einstellung der Landwirte (Schewe und Stuart 2015) und der Wahrnehmung der (Be-)Nutzerfreundlichkeit von digitalen Technologien (Michels et al. 2019) beeinflusst.

Der Implementierungsprozess und die Technikfolgenabschätzung (TA) für die kleinstrukturierte Landwirtschaft wurden bisher nicht im betriebsinternen Kontext untersucht. Die vorliegende Studie zielt darauf, einen Einblick in die möglichen sozialen Folgen auf einzelbetrieblicher Ebene zu gewinnen. Anhand von Experteneinschätzungen sollen innerbetriebliche Auswirkungen und Herausforderungen des Einsatzes von digitalen Technologien sowie zukünftige Strategien für den Umgang mit einzelbetrieblichen Schwierigkeiten und negativen Folgen ermittelt werden. Die qualitative Erhebung untersucht am Beispiel der kleinstrukturierten Landwirtschaft Baden-Württembergs folgende Forschungsfragen: Wie stellt sich der Implementierungsprozess von digitalen Technologien dar? Welche sozialen Folgen für die Landwirte im Betriebsalltag werden von Experten wahrgenommen? Welche Schwierigkeiten stellen sich demnach für die Landwirte im Implementierungsprozess? Wie können diese zukünftig gelöst werden?

Material und Methoden

Zwischen März und Juni 2021 wurden 38 qualitative Experteninterviews im Rahmen des „DiWenkLa“-Projektes (Digitale Wertschöpfungsketten für eine nachhaltige kleinstrukturierte Landwirtschaft) in Baden-Württemberg durchgeführt. Die Expertenauswahl wurde anhand eines Stakeholder-Ansatzes getroffen: Um die Auswirkungen und Entwicklungsmöglichkeiten für die kleinstrukturierten Betriebe aus möglichst vielen Perspektiven zu erfassen, beinhaltet die Stichprobe Akteure aus den Bereichen Forschung (12), Handel und Beratung (2), Maschinenringe und Lohnunternehmer (2), Agrarverwaltung und Landesanstalten (8), Industrie (9), Weiterbildungseinrichtungen (1) und Landwirte (4). Die Akteure sind größtenteils im Implementierungsprozess der Landwirte involviert, wodurch differenzierte Einblicke möglich sind. Die Interviews wurden anhand eines Leitfadens geführt, aufgezeichnet und transkribiert. Anschließend wurde eine qualitative Inhaltsanalyse nach Mayring (2015) mit der Software „MAXQDA“ durchgeführt und das Prinzip der deduktiven Kategorienbildung und strukturellen Inhaltsanalyse genutzt (Mayring 2015). Die Ergebnisse werden z. T. anhand der Häufigkeit der Nennungen der Experten dargestellt und diskutiert. Die dargestellten Antwortkategorien ergeben sich aus der qualitativen Inhaltsanalyse der Interviewtranskripte.

Innovationsbereitschaft und Technikaffinität, aber zum Teil auch das Alter der Landwirte, spielen eine wesentliche Rolle für die Nutzung digitaler Technologien.

Im Rahmen des Beitrags wird auf die Vorgehensweise der TA nach Grunwald (2010) zurückgegriffen, um die sozialen Folgen zu analysieren. Die TA zeichnet sich durch einen transdisziplinären Ansatz v. a. für die Abschätzung von gesellschaftlichen Folgen aus. Das Vorgehen ist auf verschiedene Themengebiete anwendbar, ein Beispiel ist der Einfluss der Automatisierung auf den Bereich der Arbeit. Im Folgenden wird dieses auf die kleinstrukturierte Landwirtschaft übertragen, dabei steht die Nutzung von digitalen Technologien im Fokus. Der Schwerpunkt liegt auf der einzelbetrieblichen Betrachtung für den Landwirt. In Anlehnung an die oben genannte Vorgehensweise der TA erfolgt zu-

1 Das im Folgenden verwendete generische Maskulinum soll im Sinne der Gleichbehandlung für alle Geschlechter stehen.

 https://doi.org/10.14512/tatup.31.3.65

nächst die Erläuterung der Problemstellung, die Beschreibung der Ausgangssituation der Nutzung von digitalen Technologien und der Folgen für die betroffene Personengruppe. Auf die dort genannten Technologieschwerpunkte bezieht sich die nachfolgende Analyse. Die Folgen auf den Arbeitsalltag und die innerbetriebliche Zusammenarbeit durch den Einsatz von digitalen Technologien werden anhand zusammengetragener Expertenmeinungen diskutiert. Darüber hinaus werden die einzelbetrieblichen Schwierigkeiten für die Landwirte im Implementierungsprozess betrachtet, um in einem letzten Schritt zukünftige Handlungsoptionen in Form von Lösungsansätzen zu entwickeln.

Ergebnisse und Diskussion

Beschreibung der Nutzer digitaler Technologien und Implementierungsumfeld

In der Außenwirtschaft (d. h. Acker- und Gemüsebau) nehmen die Experten eine hohe Implementierungsrate bei sogenannten „Einstiegstechnologien" wahr, z. B. bei automatischen Lenksystemen, Spurführungssystemen sowie Ackerschlagkarteien. Im Bereich der Innenwirtschaft (d. h. Tierhaltung) sehen die Experten aktuell eine erhöhte Nutzung von Melkrobotern, Sensorsystemen zur Verhaltensüberwachung (Brunsterkennung, Abkalbealarm) von Tieren (v. a. Milchvieh) sowie digitalen Technologien im Fütterungsbereich (Futterautomaten, Futteranschieberoboter). Diese Einschätzungen decken sich mit dem aktuellen Stand der Forschung zur Technologienutzung in Deutschland allgemein (Gabriel et al. 2021; Kehl et al. 2021) sowie in der kleinstrukturierten Landwirtschaft in Bayern (Gabriel und Gandorfer 2020). 21 Experten äußerten sich zum Ausmaß der Nutzung von digitalen Technologien für den Betrieb. Sieben Experten stufen den Einsatz von Digitalisierung als Ergänzung der bisherigen Arbeitsprozesse auf den Betrieben ein, die sich in den gewohnten Betriebsalltag eingliedert. 14 von 21 Experten sehen deren Einsatz als technologiespezifischen, komplexen Systemwechsel für den Betrieb, d. h., dass sich die bisherige Organisation des Arbeitsalltages grundlegend ändert. Zum Systemwechsel komme es vorwiegend bei Technologien, bei denen Arbeit durch Kapital substituiert wird, z. B. bei Melkrobotern oder Fütterungs- und Entmistungstechnologien. Für jeden Betrieb stellt sich die Einführung einer neuen Technologie individuell unterschiedlich dar und ist laut Experten v. a. geprägt von einem in der Regel hohen Zeitaufwand, nötiger externer Unterstützung durch Schlüsselpartner wie z. B. Handel, Hersteller oder Beratung sowie von einem hohen Kommunikationsaufwand. Auch sind vorherige Erfahrungen mit technischen Investitionen, die generelle Einstellung und Technikaffinität relevant für den Implementierungserfolg.

Die Experten charakterisieren die Landwirte, die digitale Technologien nutzen und somit von möglichen Implementierungsfolgen betroffen sind, größtenteils als junge, innovative Generation von technikaffinen Landwirten mit einem höheren Bildungsabschluss. Einzelne Experten halten fest, dass anstelle des Alters die Innovationsbereitschaft und Technikaffinität eine wesentliche Rolle spielen, was Hinweise für die gezielte Unterstützung der Nutzergruppe liefert.

Abschätzung sozialer Folgen und ihre Einordnung

Gemäß den Experten zeigen sich betriebliche Folgen insgesamt im Bereich der Arbeit, des Zusammenlebens und der Familie (siehe Abbildung 1). Insgesamt überwiegen die Nennungen von positiven Folgen mit 69 Nennungen die negativen Folgen mit 46 Nennungen. Deutlich ist, dass der Flexibilität der Arbeitszeitgestaltung (24) eine hohe Relevanz zugeschrieben wird. Zwar ändert sich nicht zwingend die Gesamtarbeitszeit, allerdings lässt sich die Zeit flexibler einteilen (z. B. beim Melkroboter), da strikte Zeiten bei Routinearbeiten wegfallen oder Arbeitszeit ohne zusätzlichen Aufwand effizienter genutzt werden kann (z. B. beim automatisierten Lenksystem). Dadurch kann die erhöhte Stresswahrnehmung von Routinearbeiten (Umstätter 2018) reduziert werden, v. a. für kleinstrukturierte und gering spezialisierte Betriebe mit knappen Faktoren wie Zeit oder (Fremd-)Arbeitskraft zeigt sich eine erhöhte Brisanz.

Ferner betonen die Experten, dass es zu einer physischen und psychischen Entlastung im Arbeitsablauf (22) kommt, was sich z. B. beim Lenksystem durch einen hohen Fahrkomfort und bes-

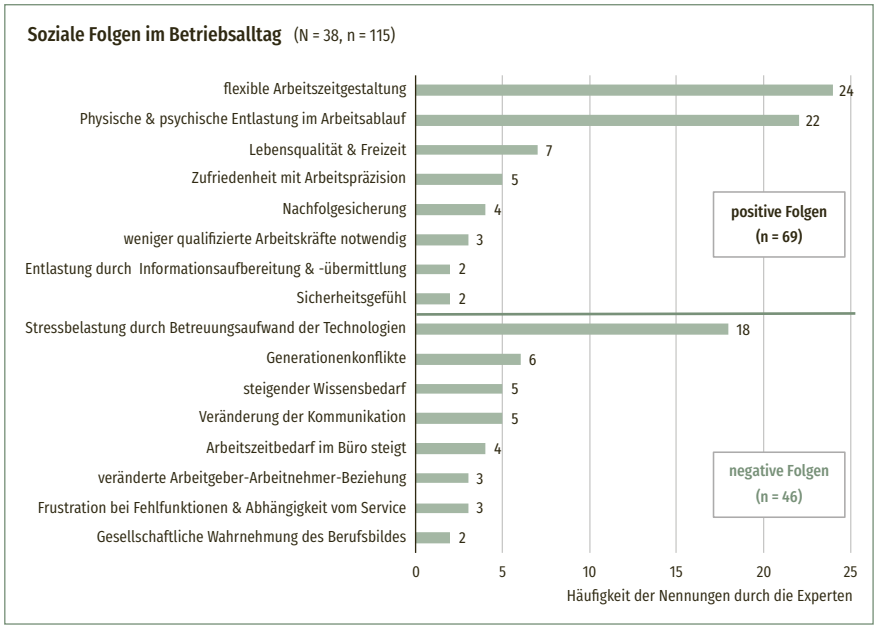


Abb. 1: Wahrgenommene positive und negative Folgen aus Expertensicht. *Quelle: eigene Erhebung*

https://doi.org/10.14512/tatup.31.3.65

seren Konzentrationsgrad äußere. Auch lassen sich einige Routinearbeiten körperlich entlasten. In der bisherigen Forschung v. a. in großen Agrarstrukturen wurden bereits ähnliche positive Wirkungen, wie z. B. die körperliche Entlastung oder die Flexibilisierung, beobachtet (Rohleder et al. 2020; Goller et al. 2021). Dadurch, dass Landwirte teilweise mehr Freizeit bzw. Familienzeit haben oder diese besser einteilen können, ergeben sich laut der Experten positive Effekte für die Lebensqualität (7). Diese Steigerung der Lebensqualität sehen Sparrow und Howard (2021) ebenfalls durch Einsatz von Techniken der Robotik gegeben. Somit zeigt sich aber auch für den Bereich der Einstiegstechnologien in kleineren Agrarstrukturen ein ähnlicher Effekt wie bei komplexeren Technologien in großen Strukturen. Neben einer höheren Zufriedenheit mit der Präzision des Arbeitsergebnisses (5) sowie der Nachfolgesicherung durch ein positives Image für das Berufsbild (4) zeigen die Experten weitere positive Folgen auf. Vereinzelt wird betont, dass im Gemüsebau durch digitalisierte Arbeitsprozesse weniger und geringer qualifizierte (Saison-)Arbeitskräfte benötigt werden (3), womit Vorteile für den Betrieb verbunden sind. Den Experten zufolge begründet sich dies darin, dass v. a. die Maschineneinstellung oder fachspezifisches Wissen teilweise durch die Digitalisierung abgedeckt werden. Ferner ist für die Arbeitskomplexität eine positive, entlastende Folge, dass Informationen durch digitale Technologien gezielter an die Landwirte weitergegeben und aggregiert verarbeitet werden können (2). Zudem steigt das Sicherheitsgefühl z. B. vor Kontrollen durch eine gesicherte Dokumentation und weniger Fehlerquellen (2).

Eine relevante negative Folge sehen die Experten vor allem im Bereich der höheren psychischen Stressbelastung durch die als ständig notwendig wahrgenommene Erreichbarkeit und Verfügbarkeit für die digitalen Technologien (18), v. a. bei Notfallalarmen von Melkrobotern, Gesundheitsüberwachungs-, Fütterungs- oder Abkalbesystemen. Goller et al. (2021) deuten dies ebenfalls für mittlere Strukturen an. Allerdings betonen vereinzelt Experten der Industrie, dass der Grad dieser Belastung individuell stark variieren kann. Hinweise gibt es auch dazu, dass es zu sozialen Spannungen und Auseinandersetzungen zwischen Generationen kommen kann (6), z. B. bei Schwierigkeiten oder ausbleibenden Erfolgen in der ersten Zeit. Neben dem Konfliktpotenzial sieht ein Experte der Agrarverwaltung durch die Wertschätzung seitens der älteren Generation für die (digitalen) Kompetenzen und Affinitäten der jüngeren Generation einen positiven Effekt durch einen entsprechenden Respekt von altersspezifischen Fähigkeiten für den Generationenaustausch. Bei den positiven Folgen v. a. im Gemüsebau wird deutlich, dass niedrig qualifizierte Arbeitskräfte mit digitalen Techniken unterstützt werden und weniger Fachpersonal nötig ist. Allerdings zeigen Experten auf, dass dann der Wissensbedarf für das Management von digitalen Technologien v. a. für den Betriebsleiter ansteigt und damit auch die Qualifikationsanforderungen (5). In der bisherigen Forschung bestätigt sich diese Einschätzung vor allem für große bis mittlere Strukturen (Schewe und Stuart 2015; Sparrow und Howard 2021) sowie die Brisanz des Fachkräftemangels hierbei (Borges et al. 2017). Ferner werden Veränderungen der Kommunikation durch mehr Zweckgebundenheit und weniger soziales Miteinander im Rahmen der Kommunikationswege sowie die Gefahr des Ausschlusses von älteren Generationen gesehen (5).

Eine negative Folge sehen die Experten vor allem im Bereich der höheren psychischen Stressbelastung durch die als ständig notwendig wahrgenommene Erreichbarkeit und Verfügbarkeit für die digitalen Technologien.

Den Experten zufolge zeigt sich, dass v. a. positive Folgen wie eine flexiblere Arbeitsgestaltung, höhere Lebensqualität, gesicherte Hofnachfolge und neue Geschäftsmodelle für kleinstrukturierte (Familien-)Betriebe eine wichtige Rolle spielen, um langfristig wettbewerbsfähig bleiben zu können. Gleichermaßen ist zu berücksichtigen, dass die obigen positiven Effekte auch auf großstrukturierte Betriebe zutreffen können, allerdings ist die zukünftige Wettbewerbsfähigkeit kleinstrukturierter Betriebe u. U. limitiert. Daher kann die Digitalisierung in der kleinstrukturierten Landwirtschaft bei erfolgreicher Implementierung und der Ausnutzung der positiven Folgen als Hilfsmittel für die Zukunftsfähigkeit der Betriebe gesehen werden. Solche Effekte, wie auch das zunehmende Sicherheitsgefühl im Arbeitsablauf und der Dokumentation wurden in der Forschung zur Wirkung von digitalen Technologien auf (Familien-)Betrieben in der kleinstrukturierten Landwirtschaft bisher noch nicht untersucht. Negative Folgen wie höhere Stressbelastung durch ständige Erreichbarkeit, mögliche Spannungen durch veränderte Kommunikationsformen zwischen Generationen sowie Frustration bei Fehlfunktionen oder Funktionsausfällen können im familiäreren Rahmen an Dynamik gewinnen. Diesbezüglich wurden die möglichen Auseinandersetzungen zwischen mehreren Generationen in der bisherigen Forschung noch nicht näher untersucht. Zwar sind die Folgen wie z. B. die flexible Arbeitsgestaltung unabhängig von der individuellen Technikaffinität und digitaler Kompetenz, sie kommen vielmehr von der Technologiebeschaffenheit selbst, dennoch sind diese aus Expertensicht relevant für

 https://doi.org/10.14512/tatup.31.3.65

den (zeitnahen) Implementierungserfolg und die damit verbundene psychische Stressbelastung. Grundsätzlich sind gemäß der Experten die früheren Erfahrungen mit Technologieinvestitionen ein wichtiger Faktor für das Ausmaß und den Umgang mit sozialen Folgen im Arbeitsalltag (Schewe und Stuart 2015). Der Anstieg von Wissensbedarf und digitaler Kompetenz sowie die mögliche Veränderung der Kommunikation stellen Folgen dar, die individuell sind und sich bei der älteren Generation zusätzlich negativ auswirken können.

Schwierigkeiten im Implementierungsprozess und entsprechende Handlungsoptionen

Zu strukturunabhängigeren einzelbetrieblichen Schwierigkeiten während der Implementierung zählen die Experten zunächst die fehlende digitale Kompetenz bei Landwirten, Händlern und anderen Akteuren (Berater, Ausbilder) bedingt durch fehlende Aus- und Weiterbildung. Daran anschließend zeigen die Experten auf, dass Traditionsbewusstsein, fehlende Veränderungsbereitschaft und eine generell skeptische Einstellung zu digitalen Technologien erschwerend im Implementierungsprozess wirken. Einzelne Experten weisen auf den Datenschutz und dessen rechtliche Rahmenbedingungen als weitere Herausforderung hin. Als spezifisch für kleinstrukturierte Betriebe werden dagegen deren mangelnde Kapazitäten betrachtet, dieser Problematik adäquat zu begegnen.

Weitere einzelbetriebliche Schwierigkeiten, v. a. auf kleinstrukturierten (Familien-)Betrieben, sind die Generationenkonflikte sowie die fehlende Unterstützung der Familie, fehlende technische Ausstattung und Angst der Landwirte vor externen Abhängigkeiten. Darüber hinaus bestehen den Experten zufolge erhöhte Schwierigkeiten in der fehlenden Systemkompatibilität, v. a. mit Blick auf die relativ hohe Markenvielfalt bei Technologien auf kleinstrukturierten Betrieben. Denn oftmals sind die Technologien hinsichtlich der Herstellerfirmen und des Investitionsalters sehr vielseitig. Auch wird deutlich, dass der hohe Zeitaufwand bei der Implementierung durch den hohen Komplexitätsgrad bei einer ohnehin hohen Arbeitsbelastung auf oftmals vielseitigen, kleinstrukturierten (Familien-)Betrieben ein grundlegendes Problem darstellt.

Analyse von Handlungsoptionen

Bisher gibt es einzelne Hinweise, wie kleineren Betrieben der Zugang zur Digitalisierung erleichtert werden kann (Kehl et al. 2021). Unklar ist aber, welche Handlungsoptionen v. a. während der Implementierung für kleinstrukturierte Betriebe relevant sind. Wesentliche Ansatzpunkte der Experten hierzu werden in Abbildung 2 dargestellt und nachfolgend eingeordnet. Anzumerken ist, dass sich alle Ansatzpunkte grundsätzlich auch auf andere Agrarstrukturen übertragen lassen. Allerdings sind die folgenden Aspekte v. a. in der kleinstrukturierten Landwirtschaft relevant, da die betrieblichen Gegebenheiten, wie z. B. weniger (spezialisierte) (Fremd-)Arbeitskräfte und Zeit, Vielseitigkeit der Betriebsleiter, geringerer Spezialisierungsgrad, heterogene und/oder kleine Schläge oder hohe Markenvielfalt, die Situation im Umgang mit den Herausforderungen durch digitale Technologien verschärfen. Daher ist es wesentlich, v. a. in den Bereichen der Technologie, Wissenstransfer und Support, gezielt die (Familien-)Betriebe zu adressieren.

Ein Großteil der Experten sieht wichtige Ansatzpunkte im Bereich der Technologie, so z. B. in der Optimierung der Bedienungsfreundlichkeit, Zuverlässigkeit und Zweckhaftigkeit (Michels et al. 2019). Weiterhin betonen die Experten technologiebezogene Lösungsansätze durch die Schnittstellenstandardisierung und die Kompatibilitätsverbesserung, diese Relevanz zeigen auch Gabriel et al. (2021). Zudem erachten v. a. Experten der Industrie den Einbezug der Landwirte in die Entwicklung durch Tests und Feedback sowie gezielte Bedarfsanalysen für höchstrelevant, hilfreich wäre z. B. die Einführung eines Qualitätschecks für digitale Technologien.

Mit Blick auf die Adoptions- und Innovationsforschung wird die Relevanz des Einbezugs der Landwirte durch Higgins et al. (2017) und Kernecker et al. (2020) dargestellt. An zweiter Stelle sehen die Experten einen Ansatz im Wissenstransfer und Kompetenzaufbau. Überwiegend beziehen sie sich auf die klare Kommunikation des Mehrwerts der digitalen Technologien für die Landwirte durch weitere Ansätze für Beratung, Bildung, Veranstaltungen, Demonstrationen sowie Coaching. Zudem betonen die Experten den gezielten Erfahrungsaustausch zur Abmilderung der Schwierigkeiten während der Implementierung. Der Ansatzpunkt deckt sich damit, dass der Wissens- und Kompetenzstand der Landwirte sowie die Weiterbildung relevant für den Umgang mit digitalen Technologien sind (Farmbusiness Skillnet Ireland 2019; Goller et al. 2021; Zscheischler

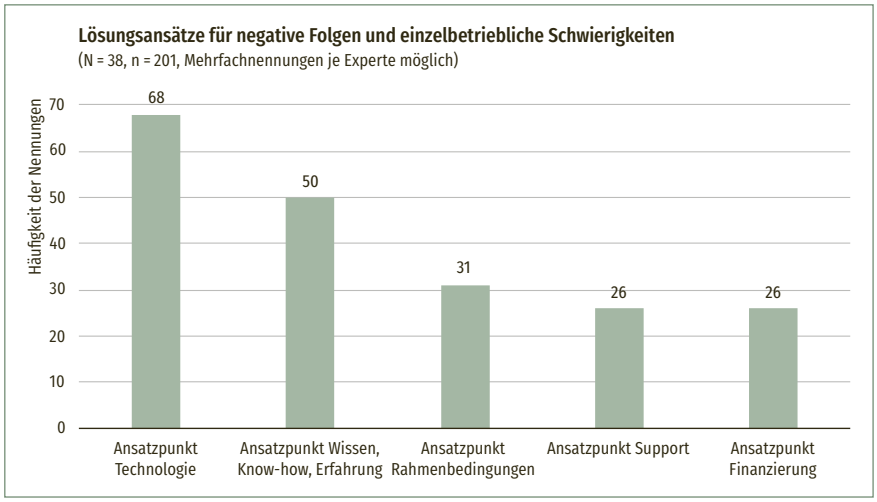


Abb. 2: Mögliche Lösungsansätze aus Expertensicht. *Quelle: eigene Erhebung*

et al. 2022) und Landwirte den Erfahrungsaustausch bevorzugen (Gabriel und Gandorfer 2020). Ferner ist die fachliche Unterstützung während des Implementierungsprozesses ein weiterer Ansatzpunkt. Gezielte Konzepte sind vernetzte Support- und Kompetenzzentren mit Unterstützung bei der Einführung oder Digitalisierungschecks der Betriebe. Diesbezüglich ist der Gebrauchtwarenhandel über Dritte zu berücksichtigen, da hierbei der Startsupport der Herstellerfirmen ausbleibt. Insgesamt ist die gezielte Unterstützung der Landwirte durch Schlüsselpartner v. a. aus der Industrie und Beratung relevant, wobei z. T. die fehlende Kompetenz der Landwirte zu Beginn der Implementierung kritisch gesehen wird. Daher ist ein sukzessives Vorgehen mit Beachtung der bisherigen digitalen Ausstattung von Betrieben sinnvoll (Farmbusiness Skillnet Ireland 2019).

Fazit

Die vorliegende Studie hat die Einführung digitaler Technologien in der kleinstrukturierten Landwirtschaft am Beispiel von Baden-Württemberg zum Gegenstand und konzentriert sich auf Experteneinschätzungen zu deren einzelbetrieblichen Folgen, Schwierigkeiten und Lösungsansätze für den Umgang mit Herausforderungen. Deutlich wird die Vielfalt technologiespezifischer Folgen, die sich von Betrieb zu Betrieb stark unterscheiden können. Ergänzend zu bisherigen Studien im soziökonomischen Bereich zeigt sich für den Kontext der kleinstrukturierten Landwirtschaft, dass Folgen im Bereich der Nachfolgesicherung und des Sicherheitsgefühls der geleisteten Arbeit, aber auch Folgen im sozialen Spannungsfeld von Generationen und Kommunikationsveränderungen relevant sind. Um gezielte, individuell anpassbare Konzepte zu erarbeiten, ist es notwendig, soziale Folgen und potenzielle Lösungswege für die Übernahme der spezifischen Technologie aus Sicht der Landwirte quantitativ und qualitativ zu überprüfen. Diesbezüglich können qualitative Erfahrungen aus Sicht von Experten und Landwirten aus anderen Bundesländern mit kleinstrukturierter Landwirtschaft validierend unterstützen. Um dann mit den beteiligten Akteuren Lösungen zu entwickeln, lässt sich bereits aus der Situationsbeschreibung und Expertenbefragung schließen, dass Akteure von Industrie, Handel, Politik, Bildung, Beratung und Forschung gleichermaßen gefragt sind. Ferner bietet sich die Entwicklung von Entscheidungshilfen bei Investitionen sowie von Angeboten zur Begleitung und Unterstützung der Implementierung an. Diese Angebote sollten die technologiespezifische Unterstützung berücksichtigen, aber auch Aspekte wie z. B. den Umgang mit der ständigen Erreichbarkeit und den veränderten Kommunikationswegen.

Experten erachten den Einbezug der Landwirte in die Entwicklung durch Tests und Feedback sowie gezielte Bedarfsanalysen für höchstrelevant.

Funding • The project DiWenkLa is supported by funds of the Federal Ministry of Food and Agriculture based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food under the innovation support programme (grant reference 28DE106B18). DiWenkLa is also supported by the Ministry for Food, Rural Areas and Consumer Protection Baden-Württemberg.

Competing interests • The authors declare no competing interests.

Literatur

Birner, Regina; Daum, Thomas; Pray, Carl (2021): Who drives the digital revolution in agriculture? A review of supply-side trends, players and challenges. In: Applied Economic Perspectives and Policy 43 (4), S. 1260–1285. https://doi.org/10.1002/aepp.13145

Borges, Friederike; Kernecker, Maria; Knierim, Andrea; Wurbs, Angelika (2017): Report on factors affecting innovation, adoption and diffusion processes. Müncheberg: o. V. Online verfügbar unter https://www.smart-akis.com/wp-content/uploads/2017/04/D2.3_Report-on-factors-affecting-innovation-adoption-and-diffusion-processes.pdf, zuletzt geprüft am 06. 09. 2022.

Cisternas, Isabel; Velásquez, Ignacio; Caro, Angélica; Rodríguez, Alfonso (2020): Systematic literature review of implementations of precision agriculture. In: Computers and Electronics in Agriculture 176, S. 105 626. https://doi.org/10.1016/j.compag.2020.105626

Farmbusiness Skillnet Ireland (Hg.) (2019): Digital agriculture technology. Adoption and attitudes study. Dublin: Irish Farm Center Ireland. Online verfügbar unter https://www.skillnetireland.ie/wp-content/uploads/2019/11/IFA-Skillnet-Digital-Agriculture-Technology.pdf, zuletzt geprüft am 06. 09. 2022.

Gabriel, Andreas; Gandorfer, Markus (2020): Landwirte-Befragung 2020 Digitale Landwirtschaft Bayern. Ergebnisübersicht (n = 2.390). Ruhstorf an der Rott: Bayerische Landesanstalt für Landwirtschaft. Online verfügbar unter https://www.lfl.bayern.de/mam/cms07/ilt/dateien/ilt6_praesentation_by_2390_27082020.pdf, zuletzt geprüft am 06. 09. 2022.

Gabriel, Andreas; Gandorfer, Markus; Spykman, Olivia (2021): Nutzung und Hemmnisse digitaler Technologien in der Landwirtschaft. Sichtweisen aus der Praxis und in den Fachmedien. In: Berichte über Landwirtschaft – Zeitschrift für Agrarpolitik und Landwirtschaft 99 (1), S. 1–27. https://doi.org/10.12767/buel.v99i1.328

Goller, Michael; Caruso, Carina; Harteis, Christian (2021): Digitalisation in agriculture. Knowledge and learning requirements of German dairy farmers. In: International Journal for Research in Vocational Education and Training 8 (2), S. 208–223. https://doi.org/10.13152/IJRVET.8.2.4

Grunwald, Armin (2010): Technikfolgenabschätzung. Eine Einführung. Berlin: edition sigma. https://doi.org/10.5771/9783845271057

Higgins, Vaughan; Bryant, Melanie; Howell, Andrea; Battersby, Jane (2017): Ordering adoption. Materiality, knowledge and farmer engagement with precision agriculture technologies. In: Journal of Rural Studies 55, S. 193–202. https://doi.org/10.1016/j.jrurstud.2017.08.011

Kehl, Christoph; Meyer, Rolf; Steiger, Saskia (2021): Digitalisierung der Landwirtschaft. Gesellschaftliche Voraussetzungen, Rahmenbedingungen und Effekte.

Teil II des Endberichts zum TA-Projekt (Arbeitsbericht, Nr. 194). https://doi.org/10.5445/IR/1000142951

Kernecker, Maria; Knierim, Andrea; Wurbs, Angelika; Kraus, Teresa; Borges, Friederike (2020): Experience versus expectation. Farmers' perceptions of smart farming technologies for cropping systems across Europe. In: Precision Agriculture 21 (1), S. 34–50. https://doi.org/10.1007/s11119-019-09651-z

Mayring, Philipp (2015): Qualitative Inhaltsanalyse. Grundlagen und Techniken. Weinheim: Beltz. https://doi.org/10.1007/978-3-531-18939-0_38

Michels, Marius; Bonke, Vanessa; Musshoff, Oliver (2019): Understanding the adoption of smartphone apps in dairy herd management. In: Journal of dairy science 102 (10), S. 9422–9434. https://doi.org/10.3168/jds.2019-16489

Rogers, Everett (2003): Diffusion of innovations. New York: Free Press.

Rohleder, Bernhard; Krüsken, Bernhard; Reinhardt, Horst (2020): Digitalisierung in der Landwirtschaft 2020. Bitkom; DBV; Landwirtschaftliche Rentenbank: o. O. Online verfügbar unter https://www.bitkom-research.de/system/files/document/200427_PK_Digitalisierung_der_Landwirtschaft.pdf, zuletzt geprüft am 06. 09. 2022.

Schewe, Rebecca; Stuart, Diana (2015): Diversity in agricultural technology adoption. How are automatic milking systems used and to what end? In: Agriculture and Human Values 32 (2), S. 199–213. https://doi.org/10.1007/s10460-014-9542-2

Sparrow, Robert; Howard, Mark (2021): Robots in agriculture: prospects, impacts, ethics, and policy. In: Precision Agriculture 22, S. 818–833. https://doi.org/10.1007/s11119-020-09757-9

Stala – Statistisches Landesamt Baden-Württemberg (2021): Landwirtschaftszählung 2020. Strukturen im Wandel. Stuttgart: Statistisches Landesamt Baden-Württemberg. Online verfügbar unter https://www.statistik-bw.de/Service/Veroeff/Statistik_AKTUELL/803421006.pdf, zuletzt geprüft am 05. 09. 2022.

Umstätter, Christina (2018): Stresswahrnehmung in der Schweizer Landwirtschaft. In: Franz Handler und Petra Renz (Hg.): 21. Arbeitswissenschaftliches Kolloquium. Arbeit in der Digitalen Transformation. Wieselburg: HBLFA Francisco Josephinum, S. 17–24. Online verfügbar unter https://ira.agroscope.ch/de-CH/Page/Einzelpublikation/Download?einzelpublikationId=38925, zuletzt geprüft am 07. 09. 2022.

Zscheischler, Jana; Brunsch, Reiner; Rogga, Sebastian; Scholz, Roland (2022): Perceived risks and vulnerabilities of employing digitalization and digital data in agriculture. Socially robust orientations from a transdisciplinary process. In: Journal of Cleaner Production 358, S. 132 034. https://doi.org/10.1016/j.jclepro.2022.132034

SARA ANNA PFAFF
arbeitet seit 2020 im DiWenkLa Projekt als wissenschaftliche Mitarbeiterin an der HfWU und promoviert zu sozioökonomischen Fragen wie z. B. zu Wirkungen durch den Einsatz von digitalen Technologien.

PROF. DR. ANDREA KNIERIM
ist seit 2013 als Professorin am Institut für Sozialwissenschaften im Agrarbereich an der UHOH tätig und leitet das Fachgebiet Kommunikation und Beratung in ländlichen Räumen. Im DiwenkLa Projekt leitet sie das Teilprojekt zur sozioökonomischen Begleitforschung.

DR. ANGELIKA THOMAS
ist seit 2017 akademische Mitarbeiterin an der HfWU und beleuchtet in der Lehre die landwirtschaftliche Bildung und Beratung. Im DiWenkLa Projekt ist sie u. a. für den Wissenstransfer zuständig.

INTERVIEW

with/mit Tim Vietor

by/von Anne Eckhardt

Swiss repositories for nuclear waste

Endlager für Atommüll in der Schweiz

The National Cooperative for the Disposal of Radioactive Waste (Nagra) in Switzerland was established on 4 December 1972. It is a cross-generational project to dispose of radioactive waste 'once and for all', including specialists from several scientific disciplines and communication experts. In September 2022, Nagra proposed a site for a deep geological repository for radioactive waste. Looking ahead to steps such as underground experiments or the specification of the layout for the deep geological repository, it is clear that many more important steps will have to be taken in the years following the siting decision. Nagra will adapt to new challenges in terms of competence and organization. Good cooperation with the siting region is just as essential as working at a high scientific level.

In Switzerland, Nagra has just proposed the site for the deep geological repository for radioactive waste. What does this mean for the affected communities, also in terms of participation opportunities?
Our announcement of the site on September 12 was a big milestone for the Swiss disposal program – also in terms of participation. Some ten years ago, regional conferences were formed in the six initial regions. Since then, we have developed our proposals for the surface facility in cooperation with the regional conferences.

In the coming years, the surface facility in the proposed siting area will be further detailed in a series of workshops. Possible layouts of the access road network, the location and extent of the construction area, as well as the logistics will be discussed here. The general license application will then be submitted in 2024.

What does this mean for the siting regions, where people have been dealing with the disposal of radioactive waste for years and where no repository is now likely to be built?
The participation process is going to be terminated in these two regions. The work in the regional conferences will be documented and archived by the Swiss Federal Office of Energy, which leads the site selection process. Some members of these regional conferences expressed regrets that they have to give up their work now. In terms of repository implementation, the two regions will be put on standby until the operational license for the repository is granted.

A deep geological repository is a major project. Is Nagra therefore transforming itself now from a rather science-based organization into a general contractor for an underground repository?
A science-based approach will always be the foundation of Nagra's activities. The Swiss plan for the disposal of radioactive waste follows a stepwise approach. In a first step, the site selection optimizes the geological setting for repository safety. The following general license is only the decision on the location and the broad framework of the project.

Further details like the repository layout, the construction methods, and the design of the technical barriers will follow once the results from the underground characterization are available. Therefore, the construction of the access facilities, the initial excavations in the host rock, and the underground experiments (Figure 1) will have to go hand in hand in order to establish the basis for the optimization of the repository.

What impact do you expect your future tasks and challenges to have on Nagra's own organization and organizational culture?
Currently, we are a project management company with some 120 people and a strong focus on earth science and disciplines related to feasibility demonstration and safety assessment.

The optimization of the facility requires the ability to create and assess multiple solutions for the repository elements and layouts. Individual elements are strongly interdependent. Consider the high-level waste (HLW) canister and the backfill material. Steel-based canister designs are robust in closure, handling, and emplacement. Their lifetime is around 10,000 years in a bentonite backfill. Coated canisters have even longer lifetimes and the backfill requirements can be relaxed. But long-term experience with copper or nickel coatings is limited, and such canisters require careful closure and emplacement. In order to finally choose the best technical barrier system, we will have to strengthen our interdisciplinary work environment. Parallel work on multiple solutions will require additional engineers with in-depth system understanding.

On top of the optimization work leading to conceptual and design decisions, we will have to strengthen our ability to construct and implement. Our engineering department will therefore definitely grow, but the final size will heavily de-

Keywords • *deep geological repository, nuclear waste, long-term project*

https://doi.org/10.14512/tatup.31.3.72
Published online: Dec. 16, 2022 (editorial peer review)

pend on how we choose to lead our contractors.

What are the future priorities of Nagra's research and development program? How will the need for research and development in the construction and operation of a deep geological repository evolve?
The safety of a repository in Opalinus Clay is broadly accepted. Clay rocks have very low hydraulic conductivities and good sorption properties. Their self-sealing capability makes them fail-safe. We can show that there are large safety margins toward the regulatory limit.

After locating the best site for the repository within the site selection program, R & D will focus on the optimization of the repository elements at the site. As mentioned, the HLW and Spent fuel (SF) canister designs will be a key point. Smaller canisters reduce local heat input, while larger canisters reduce the total number of handling steps and possibly also the size of the repository. Other engineering topics, i. e., the detailed design of the HLW/SF encapsulation plant as well as handling and operation workflows, will follow thereafter.

Does social science and humanities research have a place in Nagra's research program? Do you expect changes here over time as the deep disposal project goes ahead?
We follow the public discussion on Switzerland's energy strategy, but our mission is a technical one. Nagra acts as the implementer of the repository. We propose a concept as well as the best-suited site and implement the repository according to the best scientific and technical understanding. We act within the legal framework defined in a legislative process based on a broad discussion. This stable framework allows us to develop a project that takes more than 100 years from the site decision to the sealing of the last access.

War has once again become a realistic scenario in Europe. Are you thinking about contingency plans, for example, in the event of war or a profound financial crisis during the long construction and operation phase of a deep geological repository?
We actually have contingency measures in place for various scenarios. The repository project is financed from a fund under the oversight of the federal government. The fund is filled by the waste producers during nuclear power plant operation based on a cost calculation for the repository project. The calculation is periodically updated and includes a considerable safety margin. The financial basis for the repository project is therefore solid, also with respect to a possible financial crisis.

On top of that, we also have to provide concepts for temporary closure of the repository in its operation phase. The tunnels and caverns are immediately backfilled and sealed after waste emplacement. If necessary, a temporary closure must be possible to avoid damage to the repository during prolonged times of inactivity. Therefore, we must provide means for a temporary closure on site. This will mostly include backfill material. It is a regulatory requirement that the technique for the temporary closure is demonstrated before any waste is emplaced.

Tim Vietor

is head of the Safety, Geology and Radioactive Materials division at Nagra. As a geologist, he has expertise in planning and implementing the exploration work for a new disposal site for radioactive waste, including seismic measurements, deep boreholes, and key experiments in the rock laboratories.

In your view, are there currently any human activities, social, and technological developments that could profoundly change our perception and understanding of the safety of a deep geological repository?
An entire series of barriers ensure the highest level of safety for the repository. The performance of the natural barriers relies on diffusion-dominated transport and self-sealing of claystone. These processes are very well understood and have been repeatedly observed in the siting region. The performance of the technical barriers and the underlying process understanding have been demonstrated in underground laboratory experiments. Long lifetimes of HLW and SF canisters are ensured by low corrosion rates of steel under repository conditions. The backfill material in the emplacement tunnels protects the canisters and has excellent retention properties. All this means that a repository will have the highest safety standard under the widest range of conceivable scenarios. However, we continue research and development work to further optimize the repository.

Are there any current developments in research and technology that Nagra may wish to exploit for safety cases and for the exploration, construction, operation, and decommissioning of a repository in the future?
A safe repository can be constructed in a clay formation today. However, Nagra will exploit new developments as they arise to improve construction techniques and operational procedures. Remote handling and monitoring techniques are rapidly evolving and can be of use in an underground environment. There are also interesting developments in canister materials. However, we will always assess such developments in terms of safety, reliability, and costs.

How do you see the view of politics and society on deep geological disposal de-

https://doi.org/10.14512/tatup.31.3.72

veloping? What can we possibly expect in the future?
The approach of a deep geological repository for the safe disposal of radioactive waste is widely accepted in Swiss society. Surveys show a stable approval rate of 60 to 70 percent over the past decades. Currently, this is the internationally accepted disposal option.

Other approaches, such as transmutation, entail an entire industry including new nuclear installations. Although currently not foreseen, it may become a possibility in some decades. However, this technique is not applicable to the 632 vitrified waste packages we have from past reprocessing of spent fuel. For this category of high-level radioactive waste, a deep geological repository will always be required.

In Switzerland, the law provides for permanent marking of the repository. Are there already specific ideas about this? How do you assess the necessity of a marking?
In the underground, the repository will be protected by hundreds of meters of rock. Marking of the repository requires decisions when the repository is sealed in around 100 years. We closely follow the relevant research in this field.

Invest in top quality data and remember that scientific excellence is nothing without public acceptance.

The future is about people. Will you find enough well-trained and motivated young employees to be able to tackle and manage Nagra's tasks well in the future?
We are running a large technology-driven project with a clear and good purpose. We work for the safe disposal of nuclear waste today, so that future generations remain safe. This is a good basis for recruitment.

We cooperate with leading universities and competence centers in Switzerland to preserve and develop the knowledge at the core of the project. Nagra also takes part in research initiatives and networks at European and international level. These initiatives enlarge our network and allow us to identify qualified candidates in relevant research fields.

For the construction of the repository, we will however rely on well-established methods from the mining and tunneling industry, which has a long tradition in Switzerland. Here, we will most likely continue to work with experienced contractors.

In your experience, what interests young people about deep disposal?
We have an interesting mission, and we are a scientifically driven. You could say: The successful implementation requires a scientifically sound concept, a good and stable cooperation with the selected region, and finally the ability to construct and operate a multi-billion infrastructure project. So there will be job opportunities for a wide variety of qualifications.

What else would you like to share with us on the topic of 'The future of high-level radioactive waste disposal?'
With site-selection coming to an end after years of fieldwork and data interpretation, my personal lesson is: Invest in top quality data and remember that scientific excellence is nothing without public acceptance.

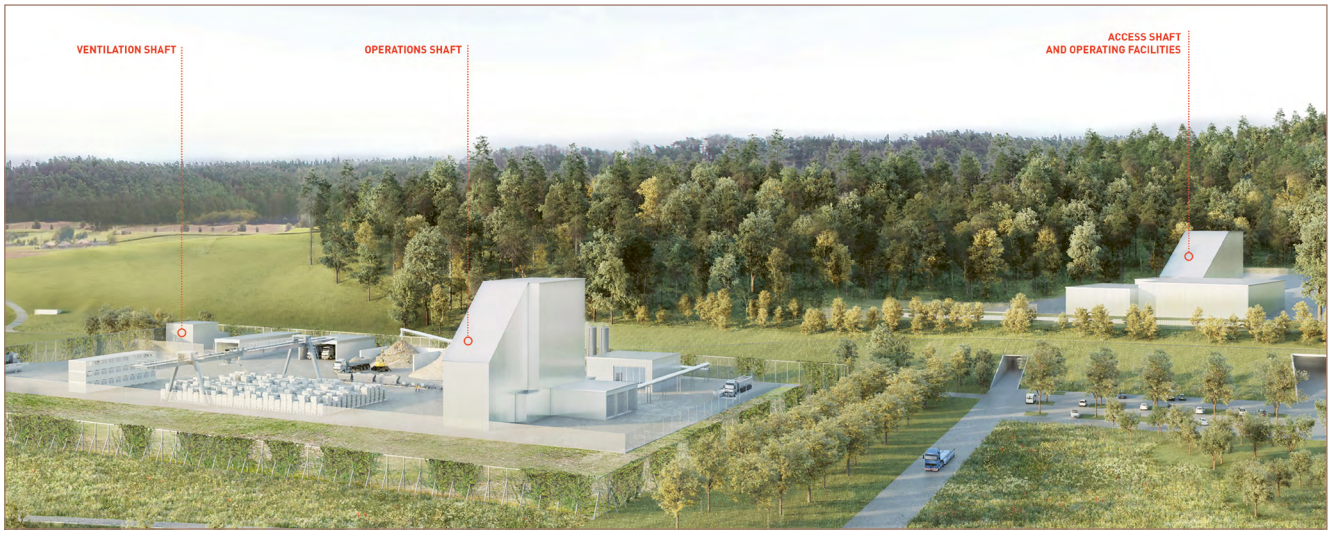


Fig. 1: A deep geological repository requires not only underground facilities, but also surface facilities that are in operation for a longer period of time. *Source: Nagra*

https://doi.org/10.14512/tatup.31.3.72

30 YEARS

UNDISZIPLINIERT!

FORSCHUNG OHNE FACHGRENZEN

GAIA – ÖKOLOGISCHE PERSPEKTIVEN FÜR WISSENSCHAFT UND GESELLSCHAFT

ist eine transdisziplinäre Zeitschrift für Wissenschaftler*innen und Wissenschaftsinteressierte, die sich mit Hintergründen, Analysen und Lösungen von Umwelt- und Nachhaltigkeitsproblemen befassen.

Sichern Sie sich jetzt Ihr vergünstigtes Probeabo!

2 Ausgaben inkl. Versand für nur **19,00 Euro**

www.gaia-online.net

oekom

Book review: Lauterbach, Karl (2022): Bevor es zu spät ist

Ernst Dieter Rossmann*,[1]

Karl Lauterbach – Bundesminister für Gesundheit, Abgeordneter des Deutschen Bundestags, Wissenschaftler, Mediziner, Vater, Sozialdemokrat – hat ein komplexes Buch geschrieben, in dem in sieben Kapiteln vier verschiedene und doch im Leben des Verfassers eng verbundene „Erzählungen" miteinander verschränkt werden, anschaulich und durchaus locker geschrieben, bisweilen etwas redundant, aber das mag der pädagogischen Ader des Hochschulprofessors und Volksvertreters geschuldet sein.

Das Buch – ein „echter Lauterbach"

Im Sinne der Transparenz sei erwähnt, dass der Verfasser dieser Rezension als Abgeordneter des Deutschen Bundestages von 1998 bis 2021 sowie als Vorsitzender des Ausschusses des Deutschen Bundestags für Bildung, Forschung und Technikfolgenabschätzung von 2017 bis 2021 Karl Lauterbach über 17 Jahre hinweg als Kollegen in der SPD-Bundestagsfraktion und im Bundestag erlebt hat. Auch wenn persönliche Urteile über Kollegen schnell merkwürdig klingen mögen: Das Buch ist in seinen Stärken wie Schwächen absolut authentisch in dem, wie der Wissenschaftler Lauterbach in seinen Darlegungen und der Politiker Lauterbach in seinen Ämtern und in der Öffentlichkeit aufgetreten ist und agiert hat. Das Buch ist insoweit ein ‚echter Karl Lauterbach' – ein Manifest in der Sorge um das Wohl der Menschen, „bevor es zu spät ist", und ein Manifest aus der Sorge heraus, „was uns droht, wenn die Politik nicht mit der Wissenschaft Schritt hält."

Das Buch ist, wie der Verlag ausdrücklich kenntlich macht, in Zusammenarbeit mit dem Biologen, Journalisten und Buchautor Lothar Frenz entstanden. Es ist in weiten Teilen ein Sachbuch von wissenschaftlicher Aktualität und doch viel mehr als nur ein Sachbuch. Es ist zugleich ein biographisch angelehntes Buch wie auch das Buch eines Vaters, der sich mit den Anliegen und Perspektiven seiner jugendlich engagierten Kinder auseinandersetzt. Es ist das Buch eines Ministers und Parlamentariers, der politische Abläufe in all ihren Facetten kennt und erklären kann, diese kritisiert und verbessern will. Und es ist das Buch eines Wissenschaftlers, der zum Politiker wurde, und eines Politikers, der von der Wissenschaft als seinem Lebensinhalt nicht lassen kann und will. Zwei Missionen will Karl Lauterbach mit diesem Buch vorantreiben: dem Klimawandel als die größte Menschheitsaufgabe für die Zukunft noch rechtzeitig und nachhaltig zu begegnen, und die zwei Systeme von Politik und Wissenschaft enger miteinander zu verknüpfen.

Die schwierige Beziehung von Wissenschaft und Politik

Die Einleitung mit dem Ausblick auf das ‚Jahrzehnt der Entscheidung' skizziert den Handlungsrahmen globaler Probleme mit dem Klimawandel als der mit Abstand drängendsten, aber nicht der einzigen Menschheitsaufgabe. Die zweifelnden, wenn auch noch nicht verzweifelten Fragen, warum wir es nicht schaffen, wissenschaftliche Erkenntnisse rechtzeitig in Handeln umzusetzen, beantwortet Lauterbach, der sich selbst als skeptischen, oder besser „realistischen Pessimisten" (S. 27) verortet, mit drei Kernforderungen. Erstens, Wissenschaftlerinnen und Wissenschaftler müssen im politischen Prozess eine ganz andere Rolle spielen als bisher. Zweitens, die liberalen Demokratien müssen dringend an Geschwindigkeit zulegen. Drittens, die Politik muss Kompetenzen an die Wissenschaft auslagern. Lauterbach fordert hier nicht weniger als „eine Revolution des Zusammenspiels von Politik und Wissenschaft" ein (S. 33).

Der schwierigen Beziehung von Wissenschaft und Politik ist denn auch das erste und mit 54 Seiten längste Kapitel des Buches gewidmet. Hier wird Lauterbach sehr persönlich und zugleich sehr direkt und sehr fordernd. Das Ideal eines Wissenschaftlers als eines politisch neutralen, allein dem Erkenntnisgewinn verpflichteten Denkers erscheint ihm nicht mehr zeitgemäß. Diese positivistische Sicht, die er in Deutschland im Unterschied zu seinem Bezugsland USA als noch zu sehr verbreitet ansieht, möchte er in eine andere Perspektive verändern – nämlich in die der Nutzung wissenschaftlicher Erkenntnisse und in politisches Engagement, erst recht, wo es „im wahrsten Sinne des Wortes lebensnotwendig" ist (S. 49).

Lauterbach, Karl (2022):
Bevor es zu spät ist. Was uns droht, wenn die Politik nicht mit der Wissenschaft Schritt hält.
Berlin: Rowohlt.
282 S., 22 Euro,
ISBN 9783737101325

* *Corresponding author: kell.rossmann@t-online.de*
[1] *Abgeordneter des Deutschen Bundestages (1998–2021), Berlin, DE*

https://doi.org/10.14512/tatup.31.3.76
Published online: Dec. 16, 2022

Auf die Politisierung der Wissenschaft sollte eine wissenschafts- und evidenzbasierte Politik folgen: ‚Raus aus dem Labor, rein in die Politik', d. h. in die Parteien wie in die Parlamente. Dass dies ein unwägbares Abenteuer ist, das aber bestanden werden kann, beleuchtet er an seinem eigenen Lebenslauf, der motiviert und Mut zur direkten Mitwirkung macht. Die acht von Lauterbach diskutierten derzeitigen Wege, wissenschaftliche Erkenntnis in der deutschen Politik zu verankern, hält er nicht für ausreichend. Dass dabei das Büro für Technikfolgen-Abschätzung des Deutschen Bundestages (TAB) übersehen wurde, ist aber mehr als befremdlich. Dies muss beiden Seiten zu denken geben, Lauterbach selbst, aber auch dem TAB und seiner Wirkungskraft ins Parlament hinein.

Lauterbach arbeitet weiterhin drei Schwierigkeiten heraus, wissenschaftliche Erkenntnisse in der Politik durchzusetzen: zunehmend wissenschaftsfeindliche statt faktenbasierte Haltungen in Teilen der Öffentlichkeit und Politik, zu wenige Wissenschaftlerinnen und Wissenschaftler in der Politik und eine zu späte und inkonsequente Einbringung der vorliegenden Erkenntnisse in den politischen Prozess verbunden mit dem Fehlen von verbindlichen wissenschaftsgeleiteten Verfahren.

Besonders interessant ist hier Lauterbachs These zum Verhältnis der Systeme Wissenschaft und Politik hinsichtlich ihrer Haltung zu Problemen: Wissenschaft suche Probleme systematisch und sehe diese als Herausforderung, während Politik Probleme vorrangig danach aussuche, dass sie zu schon vorher gefundenen realistischen Lösungen passen (S. 76). Auch deshalb brauche es zur Optimierung der Kooperation von Wissenschaft und Politik mehr Politikerinnen und Politiker mit wissenschaftlichem Hintergrund, insbesondere in den Parlamenten. Eine allgemeine Priorität politischer Ziele vor wissenschaftlichen Erkenntnissen sei nicht mehr zu akzeptieren, insbesondere hinsichtlich der Klimapolitik. Ein aus der Bekämpfung der Covid-19-Pandemie gewonnener Vorschlag sind daher Expertenräte, die fokussierte, evidenzbasierte Handlungsempfehlungen für politische Verhandlungen vorlegen.

Auf die Politisierung der Wissenschaft sollte eine wissenschafts- und evidenzbasierte Politik folgen.

Neue Aufgaben und ein Beispiel von Wissenschaftskommunikation

Ob diese Aufforderungen von Karl Lauterbach zu einem neuen Rollenverständnis von Wissenschaft die *Scientific Community*, die politischen *Brain Trusts* und die Führungsorgane wirklich erreichen, sei dahingestellt. Das Buch wendet sich nicht an die Expertinnen und Experten aus der Klimawissenschaft und wird den Fachschaften der Energiewende nichts wirklich Neues bringen können, sondern hat seine Stärken in der Erklärung von Politik und der Motivierung zum eigenen Mittun. Der hier gesetzte Impuls kann auch durch die Teile der Leserschaft weitergetragen werden, die nicht innerhalb der Wissenschaft, sondern durch die Wissenschaft angesprochen werden. In diesem Sinne werden hier in beide Richtungen, die der Wissenschaft und die der interessierten Öffentlichkeit, sehr gelungene Beispiele von guter Wissenschaftskommunikation präsentiert, d. h. die Übersetzung von belastbaren Erkenntnissen der Wissenschaft in die Rezeption einer nicht primär wissenschaftlich qualifizierten Leserschaft, z. B. eine kurze Geschichte des Klimas – vom Urknall über die Physik, die Chemie, die Biologie, den Menschen bis hin zum Treibhauseffekt –, wie sie im Zeitalter des Anthropozäns in den verbindlichen Bildungskanon gehört. Für die vertiefende Lektüre finden sich im Anhang nicht nur umfangreiche Anmerkungen mit vielen digitalen Quellen, sondern auch eine Liste von 52 relevanten Büchern aus der deutschen wie auch internationalen Literatur.

Die Kipppunkte als entscheidendes Narrativ

Lauterbach diskutiert in vier Kapiteln Schlüsselfragen für die notwendige Transformation in den Bereichen Klimaschutz, Ernährung, Wassermangel und Pandemien. Im Besonderen orientiert er sich hier am Schellnhuber-Paradigma der Kipppunkte und Dominoeffekte, also „jene(n) Schwellen, an denen ein System seine gewohnte Funktionswiese drastisch verändert oder einstellt, so dass es kein Zurück mehr gibt" (S. 19). Der Stand der Wissenschaft wird anhand gesicherter Fakten klar herausgearbeitet und gleichzeitig hütet sich der Autor vor der Verkündung letzter Wahrheiten. Das Reflektieren und Abwägen erhöht umso mehr die Überzeugungskraft der dann aufgezeigten Lösungsvorschläge. Das nimmt die Leserschaft mit, ohne sie zu überwältigen. Weil es Lauterbach so wichtig ist, scheut er sich auch nicht, frei nach Willy Brandt zu sagen: ‚Wir müssen mehr Wissenschaft wagen'. Ähnlich der damaligen Begeisterung und Engagement für Veränderung und Demokratie erwartet Lauterbach eine zukünftige Fridays-for-Future-Generation, in der er politisch den „positiven Kipppunkt sieht, auf den alle gewartet haben" (S. 253).

Rechtfertigt eigentlich ein Buch, das dieses Pathos nicht scheut, eine Besprechung und eine Empfehlung in der so rational angelegten Zeitschrift TATuP. Ich meine ja. Noch einmal Karl Lauterbach aus einem Interview in der FAZ vom 06. 03. 2022: „Für mich sind Vernunft und Moral nicht zwei Bereiche, die man ins Verhältnis setzen muss, sondern die Moral kommt aus der Vernunft." Wer Technikfolgenabschätzung betreibt, zählt zu diesen vernünftigen Moralisten. Die Aufforderung, hieraus vernünftige und moralische Politik demokratisch mitzugestalten, sollte angenommen werden.

https://doi.org/10.14512/tatup.31.3.76

Book review: Schmidt, Jan Cornelius (2022): Philosophy of interdisciplinarity

Stephan Lingner*,[1]

„We cannot tackle problems with the same kind of thinking we used when we created them." This quote from the reviewed book (p. 5) constitutes, in a nutshell, the challenge of any ambitious interdisciplinary endeavour. Recall, that manmade climate change, impacts of genetically modified organisms on natural biodiversity or societal consequences of broad digitalization are typical reasons for interdisciplinary research. Interdisciplinary perspectives offer here ways out of the shortcomings of ordinary disciplinary research regarding normative questions of risks, ethical concerns and social acceptability of techno-scientifically led innovation. Yet interdisciplinary research has not only become a familiar feature in recent decades; it is also a buzzword – sometimes even a justification for unambitious projects or poor results.

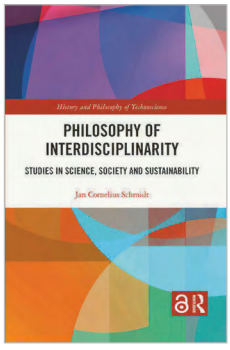
Philosophy of interdisciplinarity – an issue of TA

The *Introduction* of the reviewed publication outlines what philosophy might offer for interdisciplinary concepts and practice. The author stresses specifically its relevance, role, and challenge in connecting the spheres of science, sustainability, and society towards an overarching interdisciplinary realm. In this context, he points out that professional philosophy by itself already provides the necessary broader and more critical perspective vis-à-vis other disciplines. This specific advantage is mostly rooted in the long-lasting cross-disciplinary record of philosophy and its markedly reflexive concept of cognition building and orientational knowledge formation. Therefore, it can be expected that most ambitious interdisciplinary frameworks and efforts – like those of technology assessment (TA) – would highly benefit from the inclusion of philosophical perspectives and expertise.

The second chapter has been captioned as *Philosophy and plurality*. It takes stock of the different types of interdisciplinary and transdisciplinary practice and it provides a systematic clarification of their distinctive features and objectives of investigation. Jan Schmidt differentiates four main types of interdisciplinarity, labelled as object-, method-, theory-oriented and problem-oriented types. The latter type embodies the methods of TA and is seen as a subset of trans-disciplinarity, which might either search for effective technological and organisational means of problem reduction (instrumentalistic approach) or which might even challenge the traditional objectives and maxims of our present-day life (critical reflexive approach). Overstepping borders of even distant disciplines and sectors is therefore indispensable for any ambitious interdisciplinary purpose, which finally refers to the author's philosophical claim for "integrative non-reductionism" (p. 38) in interdisciplinary research.

Chapter 3 then moves the reader's attention to the relevance of the specific *Politics and research programs*: It addresses and reflects the relevant knowledge and research politics, which set the critical conditions and requirements for interdisciplinary research, while shaping the technoscientific future of our societies at large. The author suggests using his typology of interdisciplinary frameworks to enable classifications and assessments of corresponding politics and research programmes. He demonstrates a related analysis on a real case of the prominent US nanotechnology research programme as elaborated by the famous Roco-Bainbridge Report (2003) on converging technologies. From his analysis, Jan Schmidt insinuates this influential report a somewhat naïve naturalism. He classifies therefore this report and similar restricted approaches as technologically reductionistic. The author finally outlines needs for a stronger reflexive and normative review of corresponding interdisciplinary science politics.

History and technoscience is the title of the fourth chapter, which delves into the roots of the still dominant object-oriented mode of interdisciplinarity. Thereby, the author criticises the instrumental accord of corresponding interdisciplinary approaches, which constitute for instance the prominent reasoning patterns of current technoscientific efforts. The latter could



Schmidt, Jan Cornelius (2022):
Philosophy of interdisciplinarity.
Studies in science, society and sustainability.
London: Routledge.
206 pp., 96 GBP,
ISBN 9781138230071

* *Corresponding author: stephan.lingner@iqib.de*
[1] *Institut für qualifizierende Innovationsforschung und -beratung GmbH (IQIB), Bad Neuenahr-Ahrweiler, DE*

https://doi.org/10.14512/tatup.31.3.78
Published online: Dec. 16, 2022

be traced back to the Baconian programme and its fulfilment, which seems questionable regarding hidden trans-epistemic values and the ignorance of side-effects. Jan Schmidt criticises its unconcerned access to new knowledge and pleas therefore "to go through Bacon and deal with his program – in order to go beyond him" (p. 72) and thus beyond the complained hubris of current technoscience.

Jan Schmidt then draws attention to the issue of *Society and societal problems* (chapter 5) as points of departure for problem-oriented interdisciplinary (TA) endeavours. In this context, he reflects on different meanings of the term 'problem' and clarifies this notion in view of the most pressing extra-scientific questions of modernity – often named as 'wicked problems'. His quite broader problem perspective aims at timely answers for better and sustainable practices in society. The chapter ends with an excursus "On shortcomings of the instrumentalist view" (p. 93), which deepens the importance of orientational knowledge, supplied by appropriate frameworks of transdisciplinary research.

The following sixth chapter on *Ethics and the environment* sensitizes readers to the grand challenge to master large ecological crises, which are rooted in our modern technoscientific practice. Hence, the author puts forward the particular importance of ambitious environmental ethics for conceptualising critical-reflexive approaches of problem-oriented interdisciplinary frameworks while addressing the ambivalent consequences of techno-scientific developments. In this context, he strongly defends the relevant theses of Hans Jonas against the different objections of the partly critical scientific community. Beyond some weak points, Jan Schmidt acknowledges Jonas' metaphysical foundation overall plausibility in the sense of the urgent question: "What [new] kind of metaphysics could enable us […] to make our life more sustainable?" (p. 19). That means, that we need different mindsets towards nature, which incorporate the issues of accountability, responsibility, and stewardship. Interdisciplinarity in that sense would no longer stay unconcerned about the condition of the natural world.

In chapter 7 on *Nature and the sciences*, Jan Schmidt elaborates then the contours of an alternative conception of nature, which might better address the human-nature relation. In this context, he criticises established reductionistic approaches for the generation of scientific knowledge, which often miss the intrinsic instabilities and self-organisational characteristics of nature as well as the potentials of phenomenological and more context-related insights. Different, broader and more problem-oriented concepts of research would be needed, which would also reflect the known and unknown consequences of (human-induced) intervention in natural systems. This would even include ethically relevant orientation regarding the problematic human-nature relation – quite in the vein of Hans Jonas' thoughts. The author emphasizes that corresponding re-directions of science could then result in a new era of reflexive enlightenment.

In the final chapter on *Technology and the future*, Jan Schmidt outlines a concept of prospective technology assessment (ProTA), which is based on the above-mentioned considerations. The author's concept is directed to the very early stages of technology development for reasons to avoid any later locked-ins. This approach is accompanied by the idea of precaution as knowledge about the consequences of action is principally uncertain and incomplete – especially in the long-term perspective.

Different, broader and more problem-oriented concepts of research are needed.

That requires early normative orientation of broader and reflexive interdisciplinary assessments, which critically address not only the means but also the purposes of techno-scientific research. Applying TA-frameworks by this way might therefore help shaping ethically acceptable or even socially desirable developments. The ProTA-approach connects therefore the timely perspective of Constructive TA with the purpose-related focus of Hermeneutical TA, while adding strong normative aspirations of its reflections and outcomes.

Resume

The chapters are well arranged and follow a conclusive 'storyline', which substantiate the author's overall argument.

However, the book's overall message leaves open, how its critical reflexive ambition might be carried-out in practice and how it could *effectively* enter research policies and related techno-scientific innovation. The question is, which incentives or organisational changes could nudge the actors in a competitive world to more responsible innovation beyond volatile appellative considerations.

Some readers might also miss an overall concluding chapter of the book. However, this proves to be a more formal point – at least from a TA-perspective: The last chapter on ProTA could be rather seen as culmination of the reflections elaborated before and therefore as their ultimate result. This book is therefore highly recommended to those who need to have a deeper comprehension of ambitious professional interdisciplinarity.

Reference

Roco, Mihail; Bainbridge, William (eds.) (2003): Converging technologies for improving human performance. Nanotechnology, biotechnology, information technology and cognitive science. Dordrecht: Springer.

Book review: Ratti, Emanuele; Stapleford, Thomas (eds.) (2022): Science, technology and virtues

Janine Gondolf*,[1]

Published in 2022, the book "Science, Technology, and Virtues. Contemporary Perspectives" by editors Emanuele Ratti and Thomas Stapleford stands out in contemporary cross-sectional examination of technology and science. Most volumes in this field undeniably give into value-talk, but peculiarly refuse any insights into associated concepts and ideas. With Ratti and Stapleford, fourteen diverse contributions apparently swim against a current by staging the interchange of virtues, science, and technology as an important research perspective.

Virtue as means of inquiry

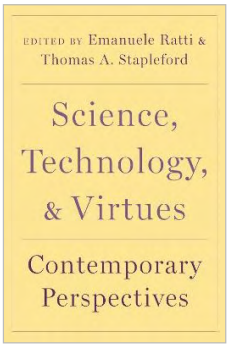
Putting together a collection seems almost as complicated as reviewing it in its entirety – particularly when the editors defensively anticipate valid criticisms in the editorial. On the one hand, the editors claim that virtues and vices are stale (p. 1); on the other, they deny that a unified approach would be necessary (p. 6). Despite the premise that 'virtue' makes an interesting research perspective, a common starting point, a shared aim, or a collective goal is missing (p. 5). So, how to cope with these challenges? The editors suggest choosing what might be helpful in one's own interests in the topic (p. 6); more a jump into the cold water than a systematic first step into the topic.

It is then the first article that reveals the basic interrelationship of virtues, science, and technology which the editorial left out. Taking stock of historic cases, Richard Bellon (p. 17) untangles in what manner traditional concepts and 'the good life' play out in pre-modern research practice. He takes his readers on an expedition on how 'man of science' as role and as status of the gentleman scientist inhibited Victorian British Science. But, a standard dogmatic conception is inherent to Bellons' inquiry: Traditional concepts of virtues assess the character of a person, or an action for (moral) judgement related to teleological ideals. Giving intelligent cases along with a detailed examination of fundamental concepts like purity and truth in science, this text is not only good reads in history and philosophy of science but instructive for further inquiry.

Meanwhile, e.g. ideas of 'epistemic virtues' have long been washed into descriptions of theories, of methods, and of processes to grasp their overall style and quality, especially in (post) modern science. Ratti's analysis of instances of 'virtue-talk' (p. 149) features this extended conceptional use and highlights the epistemic aspect of scientific activities. In everyday situations 'in science', so the story goes, considerations arise that can be captured and described well with (adapted) concepts of virtue. Whereas multifold concepts and their descriptive capacity are acknowledged by a host of literature, only seldom systematic discussion of the underlying ideas occurs. To fill this gap, a detailed overview of the prominent theories is provided, which concludes with a brief exploration of shortfalls, idealization, and misconceptions. In doing so, two concepts of virtue (virtue as excellence and virtue as character) are distinguished. Though attractive, that separation does not concede when value- and virtue-talk converges within the argument.

Within technology assessment, it is acknowledged that different valuing practices have been established throughout disciplines involved. Within all these practices, 'values' in a broad sense are analyzed because they bring to the fore normative constraints that are at play under the sociotechnical condition co-shaping science and technology. The power of value-talk lies in addressing, examining, and managing conflicting interests and hidden prerequisites.

Values can entail virtues, but must not – assessing virtues without weighing them is nonsensical, so valuing comes back in. However, virtues allow a different way of proceeding when related to, e.g., science and technology: While value concepts allow distinct separation, concepts of virtues foremost restrict analytical subdivisions and management approaches. They highlight diversity of correlations and the interplay of conditions. Three texts in different subsections elaborate concepts of virtue in that regards and use 'virtue' as signifier to illustrate the complexity



Ratti, Emanuele; Stapleford, Thomas (eds.) (2022): **Science, technology, and virtues.** Contemporary perspectives. Oxford: Oxford University Press. 76,25 Euro, ISBN 9780190081713

* *Corresponding author: janine.gondolf@kit.edu*
[1] *Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology, Karlsruhe, DE*

https://doi.org/10.14512/tatup.31.3.80
Published online: Dec. 16, 2022

of cases at hand: Stapleford and Hicks (p. 37) as well as Pennock and Miller (p. 58) and Schmidt (p. 117) assess scientificity writ large through the lenses of Alasdaire MacIntyre's virtue theory. Their discussion could integrate especially well with technology assessment practices – if it were not for the essayistic style that prevented going into detail on major concepts and their relation. It remains unclear what re-tooled 'virtue' implies and where it is connected to practices other than the cases at hand.

While questioning whether 'failing better' is an indicator for scientific virtues Jutta Schikore (p. 178) bypasses these discussions: How perception of failure and success co-shape practices in and theories of science opens up yet another perspective on how science, technology, and virtues can conflate. E.g., 'trial and error' still is a go-to epistemic pathway, not restricted to early research phases – but how to cope with it in standardized academic trajectories? What is the epistemic status of these activities that do not translate into impact figures and success stories? With technology assessment (TA) actives a multiple dependent set of diverse forms of expertise flow together. A concept of virtue that takes this into account could be very useful for this purpose.

Values can entail virtues, but must not – assessing virtues without weighing them is nonsensical.

Virtues in practice

Certain texts are exceptionally striking because of their 'virtue assessments': Martin (p. 97) contributes a survey exploring the topical formation of 'mindfulness' as a virtue when related to technology. Mindfulness in his sense idioms "paying attention to what matters in the light of relevant values" (p. 114). His argument interweaves various aspects of relating virtue, science and technology, that many other texts in this book indeed bring up. In the end, he joins traditionalists' virtue theorists, which does not diminish the depth of the text and its relevance for the discussion in this book.

Countering anything traditionalist, Laura Ruetsche's text "Virtue and Contingent History" (p. 161) straight forward motivates connecting a special way of reading Aristotelian and Bayesian takes on epistemic capacities. Showing how traditionalist (in the sense of mainstream) epistemology of science is blindfold and limited, she carves out a systematic incompleteness of said theories using her concept of virtues. She then suggests incorporating feminist epistemology (Harding, Haraway, Longino), as well as aspects of modern Aristotelian moral theory (McDowell) to fill the gap and reestablish a more relevant version of epistemology of science. Virtue, by her definition is the capacity to track context (p. 166). This idea aligns with other efforts remarrying science studies and 'that is what scientists do', which is especially current in the philosophy of science. As with the question of the epistemic status of failure, a mature concept of 'virtue in practice' could be well applicable to TA.

Dana Tulodziecki (p. 200) relates virtues to the more general, contemporary epistemological debate about foundations of scientific knowledge and scientific activity. She takes up a variety of issues (truth-conduciveness, complexity, parsimony) but insists on a concept of virtues that is empirically assessable and relevant for the philosophical debate on theory choice (why and how scientist utilize theories, esp. when equally promising or potent). Not going into detail on what that leads to for virtue theory, she argues for a non-pragmatic account of virtue assessment that enriches the debate on the wide range of aspects that enter epistemic activity altogether. In that regard, her conceptual work is instructive for thinking about virtues in an interdisciplinary collaborative research environment: Any TA activity already copes with diversity of knowledge acquisition and transferal, nonetheless specific concepts that could capture this richness are rarely available.

Different takeaways for different readers

Throughout the four thematic sections contents more or less heavily rely on recent notions of 'science in practice' as if 'topical' could indicate 'standardized'. One might well get a good glimpse at Alasdair MacIntyre's value theory, since half of the texts in this collection emphasizes his works. Giving that the book originated at a workshop at the University of Notre Dame in 2018, this might be explained by vivid discussions had back then – but it now impedes the reading flow of any not-so standalone original papers. In a row with that are texts compressing ideas into a few pages that elsewhere fill entire books. These short-forms of arguments are informative and can invite a reading of the respective work – however, an editorial epilogue that collects the scattered parts, different types of texts, and variety of concepts presented would have helped. Beyond all points of criticism, the reading is clearly recommended if one is seeking an insight into the interchange of virtues, science, and (some) technology.

https://doi.org/10.14512/tatup.31.3.80

Meeting report: „Privatsphäre, Datenschutz, Gemeinwohl: Ethische, rechtliche und soziale Herausforderungen der Nutzung von Gesundheitsdaten für die Forschung“. Conference, 2022, Karlsruhe, DE (hybrid)

Martina Baumann*,[1], Maria Maia[1], Nora Weinberger[1]

Wie kann Datenschutz und die Informierung von Patient*innen über die Nutzung ihrer Daten mit den Anforderungen der Forschungspraxis vereinbart werden? Welche rechtlichen Unklarheiten gibt es bei der Nutzung von Daten für Forschungszwecke? Wie steht es um Motivationen und gesellschaftliche Treiber für die Erhebung von Gesundheitsdaten im privaten Leben? Gibt es besonders vulnerable Gruppen für Datenmissbrauch und andere nicht-intendierte Nebeneffekte von Gesundheitstracking? Und wie kann man gesellschaftliche Diskussionen zu diesen Fragen bei den betroffenen Patient*innen und Bürger*innen mit innovativen Methoden, etwa künstlerischen Mitteln, anregen? Diese und weitere Fragen stehen im Zentrum des Verbundprojekts „DaDuHealth – Datenzugang und Datennutzung in der medizinischen Versorgung und im Bereich Gesundheit und Freizeit. Eine ethische, rechtliche und soziale Analyse“, das von 2020–2023 vom Bundesministerium für Bildung und Forschung (BMBF) gefördert wird.

Die Zusammenführung und Auswertung großer Mengen und verschiedener Arten von Gesundheitsdaten für Forschungszwecke verspricht, schwer erreichbare Probandengruppen zu inkludieren, neue Erkenntnisse zu generieren und so eine bessere Versorgung in vielen Bereichen zu ermöglichen. Dabei fallen Gesundheitsdaten sowohl im Kontext der klinischen Behandlung von Patient*innen an als auch in zunehmendem Maße durch sogenannte Consumer-Health-Technologies (CHTs). Gemeint sind hiermit so genannte Wearables wie Fitnesstracker, Blutzuckermessgeräte und Apps, die vielfältige gesundheitlich relevante Daten, etwa über körperliche Aktivität und psychisches Befinden sammeln.

Am 07. und 08. April 2022 fand die Konferenz „Privatsphäre, Datenschutz, Gemeinwohl: Ethische, rechtliche und soziale Herausforderungen der Nutzung von Gesundheitsdaten für die Forschung“, in der Triangel in Karlsruhe statt. Insgesamt rund 80 Teilnehmer*innen aus Wissenschaft und Gesellschaft fanden sich vor Ort ein oder nutzten das hybride Format, um sich aus Deutschland und einigen benachbarten Ländern zuzuschalten.

Am ersten Tag der Konferenz wurden ersten Ergebnisse des Projekts vorgestellt und diskutiert. Svenja Wiertz vom Institut für Geschichte und Ethik der Medizin von der Universität Freiburg sprach über die informierte Einwilligung zur Datenfreigabe für Forschungszwecke aus ethischer Perspektive und betonte, dass für eine Abwägung der Vor- und Nachteile verschiedener Einwilligungsformen die gesellschaftlichen Rahmenbedingungen entscheidend sei. Z. B. ist der sogenannte ‚broad consent‘ aus Sicht von Forschenden sehr vielversprechend, da er weitreichende Nutzungsrechte für gespendete Daten einräumt. Ob diese Einwilligungsform aus Sicht der Datenspender*innen auch ethisch akzeptabel ist, hängt jedoch u. a. von deren Fähigkeiten ab, die möglichen Folgen ihrer Datenspende abzuschätzen bzw. zu verstehen, sowie natürlich von der Sicherheit der Dateninfrastrukturen.

Martina Baumann vom Institut für Technikfolgenabschätzung und Systemanalyse (ITAS) des Karlsruher Instituts für Technologie stellte eine Typologie von Nutzer*innen vor, die dabei helfen soll, vulnerable Nutzergruppen und Risiken der CHT-Nutzung in Abhängigkeit von psycho-sozialen Faktoren und der Nutzungsweise zu beschreiben. Dies stelle einen wichtigen Schritt auf dem Weg zum Verständnis und letztlich der Minimierung von Risiken der Nutzung von CHTs dar.

Zum Abschluss des ersten Konferenztages zeichnete Dirk Helbing von der ETH Zürich in einer Keynote ein recht dystopisches Bild einer Überwachungsgesellschaft, die aufgrund zu zaghafter Regulierungsbemühungen die beängstigenden Potenziale emergierender Technologien nicht mehr zu bremsen vermöge. Diese Einschätzung erfuhr sehr regen Widerspruch aus dem Publikum. Die Datenschutz-Grundverordnung sei eine gut durchdachte und wirksame Maßnahme auch in Anbetracht zukünftiger Herausforderungen. Eine Reproduktion der technischen Visionen aus dem Silicon Valley sei ethisch unter Umständen sogar bedenklich, da sie schlicht ein unrealistisches Bild zukünftiger Technologien zeichne, und damit eine Beschäftigung mit ihren ethischen Implikationen eher erschwere. Aus Sicht der Technikfolgenabschätzung ist das eine sehr interessante Kontroverse, die darauf verweist, dass das Thema Gesundheitsdaten auch für einen Vision-Assessment-Ansatz, also die Untersu-

* Corresponding author: martina.baumann@kit.edu
[1] Institut für Technikfolgenabschätzung und Systemanalyse, Karlsruher Institut für Technologie, Karlsruhe, DE

https://doi.org/10.14512/tatup.31.3.82
Published online: Dec. 16, 2022

Abb. 1: Digitaler Austausch im ersten Workshop der Konferenz.
Quelle: Maria Maia

chung von Folgen und Bedeutungen von visionären Technikzukünften, prädestiniert wäre.

Am zweiten Tag der Konferenz konnten sich die Teilnehmenden an zwei Workshops beteiligen. Der erste befasste sich mit ethisch-rechtlichen Fragestellungen und umfasste Beiträge von Martin Boeker (TU München), Christoph Schickhardt (Universitätsklinikum Heidelberg) und Fruzsina Molnár-Gábor (Heidelberger Akademie der Wissenschaften). Im Fokus standen einerseits praktische Fragen (z. B. der Zeitbedarf und die daraus folgenden Kosten für informierte Einwilligungsprozesse) und der Stand der Umsetzung des ‚broad consent' in Kliniken. Andererseits wurden auch grundsätzliche Fragen wie die ethische Vertretbarkeit einer sogenannten Opt-out-Lösung (eine Einwilligung wird erst einmal als gegeben unterstellt und muss aktiv zurückgezogen werden) für die Datenspende aufgeworfen. Jüngste Befragungsstudien, die eine hohe Datenspendenbereitschaft in der deutschen Bevölkerung aufzeigten, wurden als Argument hierfür angeführt.

Beim zweiten Workshop, unter dem Titel „Consumer Health Technologies: Nutzertypen, Gesellschaftliche Trends und Datenspende für die Forschung", organisiert vom ITAS, diskutierten CHT-Nutzer*innen und Expert*innen aus der Versicherungsbranche, der Medizininformatik, der Soziologie, der Psychologie und der ‚Quantified-self'-Bewegung in kleinen Gruppen über Risiken und Potenziale der CHT-Nutzung.

Angezweifelt wurde, ob eine Unterscheidung von Nutzer*innentypen, etwa die pragmatischen (zielorientierten) und die enthusiastischen (spielerischen und technikbegeisterten) Nutzer*innen, wie sie in der sozialwissenschaftlichen CHT-Literatur oft vorgenommen wird, überhaupt sinnvoll sei. Psychologische Mechanismen und der Kontext der Nutzung würden hier komplett vernachlässigt. Eine Typologisierung von Nutzer*innen sei immer nur für spezifische (Forschungs-)Zwecke möglich.

Zudem lag der Fokus in den Gesprächen auf den Risken und Nebenwirkungen der Nutzung von CHTs, z. B. einer drohenden Normierungsgefahr insbesondere im Zusammenhang mit Social Media und einer mangelhaften Nutzungskompetenz. Hier sei eine Vermittlung durch Fachpersonal gefragt; das Ärzt*innen-Patient*innen-Verhältnis spiele eine wichtige Rolle. Ein Lösungsansatz wäre, Risikogruppen durch einige Fragen beim Start von Gesundheits- oder Fitness-Apps zu identifizieren, um unterschiedliche Modi der App auswählen oder in Form eines Disclaimers auf die besonderen Risiken für die jeweiligen Nutzer*innen hinweisen zu können.

Als Treiber für die CHT-Nutzung wurden verbesserte Datenqualität, Digitalisierung, und die steigende Verfügbarkeit von Apps gesehen, aber auch die Leistungsgesellschaft. Ein gesellschaftlicher Trend wurde auch im gestiegenen Bewegungsmangel durch die Corona-Pandemie identifiziert, gepaart mit einem erhöhten Gesundheitsbewusstsein durch Informationsangebote im Internet. Über die Frage, ob es sich bei der CHT-Nutzung vorwiegend um einen Trend der Datenerhebung oder auch der Datenanalyse durch Nutzer*innen handelt, also bürgerwissenschaftliche Elemente stark auftreten, herrschte Uneinigkeit bei den Diskutierenden.

Im Hinblick auf die Verwendung von Daten für Forschungszwecke war den Teilnehmenden die Mitbestimmung und Informierung über Verwendungszwecke ein wichtiges Anliegen. Der Gemeinwohlnutzen müsse geklärt sein, ehe Daten gesammelt würden. Außerdem müssten Patient*innen stärker an Entscheidungen zur Datennutzung beteiligt werden, etwa durch so genannte ‚use and access committees'. Akteur*innen des Gesundheitswesens betonten, wie wichtig es sei, Datensilos (insbesondere bei CHT-Herstellern) zu vermeiden und Zugang zu Daten für alle Akteur*innen mit begründeten Interessen zu ermöglichen.

Kontrovers diskutiert wurde das Verständnis von Solidarität im Gesundheitswesen. Einerseits könnten CHT-Daten-basierte Bonusprogramme die Selbstfürsorge als Element solidarischen Handelns stärken. Andererseits wurde von den Teilnehmenden ein schmaler Grat zwischen Selbstermächtigung und Zwang zur Prävention identifiziert, was umso problematischer ist, da Gesundheit eine starke soziale, also nicht willentlich veränderbare Komponente habe. Aus praktischer Sicht sollte ferner bedacht werden, dass Krankenkassen-Bonusprogramme möglicherweise nicht die Zielgruppe erreichen (wenig aktive Versicherte), sondern diejenigen, die ohnehin Fitnesstracker nutzten. Für Kassen wäre es insofern interessant herauszufinden – und hier schloss sich der Kreis zum Thema der Nutzertypen wieder – welche Versichertengruppen nicht erreicht werden, welche aber profitieren könnten.

Weitere Informationen

https://www.itas.kit.edu/projekte_baum20_daduhealth.php

https://doi.org/10.14512/tatup.31.3.82

Meeting report: „Nachhaltig Wirken – Reallabore in der Transformation“. Conference, 2022, Karlsruhe, DE

Felix Wagner*,[1], Regina Rhodius[2], Mandy Singer-Brodowski[3], Franziska Stelzer[4]

Der Reallaboransatz hat seit seinem Aufkommen 2012[1] einen richtiggehenden Boom erfahren. Reallabore sind in ihrem originären Ansatz als Experimentierräume, Forschungsmodus und methodologisches Werkzeug konzipiert, um zu nachhaltiger Entwicklung und gesellschaftlicher Transformation beizutragen und diese zu beschleunigen. Wesentlicher Ansatzpunkt ist dabei, Wissenschaft und Praxis in transdisziplinären Settings und transformativen Prozessen eng miteinander zu verknüpfen. Die Wissenschaft bzw. die Forschenden, begeben sich dabei selbst in Wandlungsprozesse: Sie initiieren, experimentieren und beforschen zugleich. Praxisakteure setzen dabei Themen und forschen aktiv mit, so dass im Idealfall sowohl wissenschaftliche Theorie als auch gesellschaftliche Praxis von den Ergebnissen profitieren. Die Ausgestaltung von Reallaborprojekten hat in den letzten zehn Jahren eine Vielzahl von Differenzierungen in Inhalten, Settings, Methodik und Ausrichtung erfahren (Wagner und Grunwald 2019).

Die Konferenz „Nachhaltig wirken: Reallabore in der Transformation“, die am 2. und 3. Juni 2022 in Karlsruhe stattfand, griff diese Entwicklungen auf, um gemeinsam mit der wachsenden Reallabor-Community den aktuellen Entwicklungsstand des Reallaboransatzes abzubilden. Organisiert vom Karlsruher Transformationszentrum für Nachhaltigkeit und Kulturwandel (KAT) in Zusammenarbeit mit den Gründungsinstitutionen des Netzwerkes Reallabore der Nachhaltigkeit, wurden auf der Tagung aktuelle methodische, konzeptionelle, praktische wie auch strategische Fragen aufgeworfen und diskutiert. Mit über 300 Teilnehmenden und 115 Beiträgen stellt sie die bislang größte und umfassendste Veranstaltung im Bereich der deutschsprachigen Reallaborforschung dar.

Inhalte

Die Konferenz-Beiträge und inhaltlichen Diskussionen strukturierten sich entlang von sechs Themenfeldern, die auch als Aspekte zur Reflektion und Evaluation der Reallaborentwicklung Verwendung finden können: 1. Reallabor-Konzepte und Forschung, 2. Innovation und Aktion für Transformation, 3. Experimentierräume eröffnen und offenhalten, 4. Bildung, Lernen und Lehre, 5. Verständigung und Vernetzung, 6. Reflexion, Kontemplation und innere Kultur der Nachhaltigkeit.

Der Anspruch einen Entwicklungsstand des Reallaborformats trennscharf abzubilden ist herausfordernd – zu groß sind die Differenzen inhaltlicher, struktureller und normativer Art zwischen den verschiedenen Reallaboransätzen. In den Präsentationen und Diskussionen, sowie den sonstigen Interaktionen wurde deutlich, dass der Zugang zum Reallaboransatz sich zuweilen von ganz unterschiedlichen Seiten vollzieht. Einerseits bildet die ‚klassisch‘ transdisziplinäre Forschung zu nachhaltiger Entwicklung einen Ausgangspunkt, der viele methodische Grundlagen für die Reallaborforschung mitbringt. Auf der anderen Seite des Spektrums steht die Forschung zu technischen oder organisationalen Innovationen, die aufgrund des Bedarfs an regulatorischen Freiräumen und gesellschaftlicher Akzeptanz zu dem Format von Reallaboren kommen.

‚Karlsruher Erklärung‘ und ‚Ethik für Reallabore‘

Im Rahmen des Jahrestreffens des Netzwerks Reallabore der Nachhaltigkeit wurden mit 80 Teilnehmenden zwei für die weitere Entwicklung und Verbreitung des Reallaborformats relevante konzeptionelle Ansätze tiefergehend beleuchtet:

Ziel der ‚Karlsruher Erklärung‘ ist, transdisziplinäre und transformative Ansätze in Wissenschaft, Wirtschaft, Zivilgesellschaft und Politik stärker zu verankern und zu fördern. Die Erklärung wird über die nächsten Monate weiterentwickelt und soll dann als Grundlage für Gespräche mit zentralen Akteur:innen der Wissenschafts(förder)landschaft dienen.

Das Forschungsprojekt ‚Ethikkodex für Reallabore‘ geht von drei Beziehungsfeldern als Grundlage aus (Reallabor zu Außenwelt; Reallabor-Projektpartner zueinander, Realaborant:innen zu sich selbst) und beleuchtet hierbei Fragen ethischer Art, wie nach dem Rollenverständnissen der Beteiligten, der Ownership des Forschungsprozesses und den Profiteur:innen der Ergebnisse. Verbindliche Richtlinien, im Sinne eines gemeinsamen Commitments zu guter wissenschaftlicher und transdisziplinärer Praxis können für Reallabore mit ihrer normativen Ausrichtung ein entscheidender Grundstein für die weitere Entwicklung des Forschungsformates werden.

1 Stellungnahme von Uwe Schneidewind im Deutschen Bundestag. Ausschuss für Bildung, Forschung und Technikfolgenabschätzung am 27. Juni 2012; A-Drs. 17 (18) 281 a.

* *Corresponding author: felix.wagner@kit.edu*
[1] *Institut für Technikfolgenabschätzung und Systemanalyse, Karlsruher Institut für Technologie, Karlsruhe, DE*
[2] *Öko-Institut e. V., Albert-Ludwigs-Universität Freiburg, Freiburg, DE*
[3] *Institut Futur, Freie Universität Berlin Institut, Berlin, DE*
[4] *Wuppertal Institut für Klima, Umwelt, Energie gGmbh, Wuppertal, DE*

https://doi.org/10.14512/tatup.31.3.84
Published online: Dec. 16, 2022

Neben diesen beiden inhaltlichen Aspekten haben die Teilnehmenden in einem ‚Gallery Walk' auf Pinnwänden verschiedene Ideen für zukünftige Aktivitäten und die Zusammenarbeit im Netzwerk diskutiert. Diese umfassten u. a. Veranstaltungen, die Transdisziplinarität des Netzwerks, mögliche Institutionalisierung und Professionalisierungsoptionen, Fortbildungsbedarfe sowie einen allgemeinen ‚Open Space', in dem Vorschläge und Wünsche an das Netzwerk ergänzt werden konnten.

Abb. 1: In einem ‚Gallery Walk' haben die Reallabor-Netzwerk-Mitglieder verschiedene Ideen für zukünftige Aktivitäten diskutiert. *Quelle: Tanja Meißner, KIT*

Kreativität und Kultur

Die Konferenz bot ein reichhaltiges Kultur- und Rahmenprogramm, das deutlich machte, dass Reallabore und Transformation mehr bedeuten, als kognitiver Wissensgewinn und Beiträge zum Klimaschutz. Besonders spürbar war das beim *Wandelweg* im Transformationsatelier, der das individuelle transformative Potenzial neben dem ökologischen Fußabdruck noch um die Dimensionen Handabdruck, Kopfhaltung und Herzschlag ergänzte und in vier interaktiven Stationen zur Reflektion einlud. Der schon länger immer wieder aufkommende Ruf nach mehr Kooperation zwischen Kunst und Wissenschaft im Transformationsgeschehen wurde neben dem künstlerischen Abendprogramm unter anderem durch eine performative Podiumsdiskussion ‚Zukunftsweltstadt Karlsruhe' aufgegriffen. Hierfür inszenierte eine Initiativgruppe (bestehend aus Wissenschaftler:innen, kommunaler Verwaltung, lokalen Akteuren, einem Regisseur und einer Illustratorin) eine Podiumsdiskussion. Diese war in der Performance zeitlich fünf Jahre in der Zukunft verortet (2. Juni 2027) und blickte damit fiktiv retrospektiv auf die Transformationsentwicklung in Karlsruhe seit der Reallaborkonferenz zurück.

Erkenntnisse aus der Konferenz

Ein Manko der Konferenz zeigte sich darin, dass trotz anders intendierter und ausgeschriebener Ausrichtung nur wenige Praxisakteure involviert waren. Dies liegt auch strukturell im Format einer wissenschaftlichen Tagung begründet (mit Call, Art der Öffentlichkeitsarbeit und Teilnahmegebühr), aber sollte unbedingt Anlass geben, über neue oder anders ausgelegte Formate nachzudenken, damit das vielzierte ‚auf Augenhöhe kooperieren' nicht dem Vorwurf der ‚Augenwischerei' anheimfallen kann.

In den Beiträgen und Inhalten der Konferenz zeichnete sich deutlich ab, dass einer der nächsten Entwicklungsschritte des Reallaboransatzes in der Institutionalisierung (gerade auch in kommunalen Kontexten) bestehen wird. Damit einher geht eine Langfristigkeit (nicht nur projektfinanzierte Struktur) und dadurch auch eine einfachere Teilhabe für eine Vielzahl (auch nichtwissenschaftlicher) Akteure. Ob gerade Karlsruhe sich dabei als ‚Mekka der Reallaborforschung' weiterentwickeln wird, so der Oberbürgermeister Dr. Frank Mentrup in seiner Würdigung, muss sich noch beweisen. Mit der Gründung des Karlsruher Transformationszentrums KAT ist hiermit zumindest ein aussichtsreiches Momentum entstanden. Auch andernorts wird es sich zeigen müssen, wie durch kommunale und regionale Verankerungen verstärkt transformative und breitere Bevölkerungsschichten involvierende Wirkungen erzielt werden können. Sicher ist jedenfalls, dass mit dem Reallaboransatz das aktuelle Bedürfnis vieler Bürger:innen und politischer Entscheidungsträger:innen, neue, innovative Lösungsansätze für gesellschaftliche Probleme zu finden, aufgegriffen wurde.

Es ist auch davon auszugehen, dass das wissenschaftliche und gesellschaftspolitische Interesse daran Bestand haben wird, vor allem wenn die inhaltliche und strukturelle Konsolidierung weiterhin gute Fortschritte erzielt.

Die gesellschaftliche Legitimation und Beteiligung wird mit der verstärkten Wahrnehmung der transformativen Wirkungen von Reallaboren ebenso zunehmen, woraus wiederum ein verstärkter Transfer und damit eine Verstärkung des Impacts von Reallaboren für die Transformation absehbar erscheint.

Literatur

Wagner, Felix; Grunwald, Armin (2019): Reallabore zwischen Beliebtheit und Beliebigkeit. Eine Bestandsaufnahme des transformativen Formats. In: GAIA. Ökologische Perspektiven für Wissenschaft und Gesellschaft 28 (3), S. 260–264.

Weitere Informationen

Webseite der Konferenz:
https://indico.scc.kit.edu/event/2597/
Netzwerk Reallabore der Nachhaltigkeit:
https://www.reallabor-netzwerk.de/

TATuPDates 31/3 (2022)

News from the editorial office / Meldungen aus der Redaktion

TATuP

32/1 (2023) will be published in March 2023 with the Special topic

„Modeling for policy“

Models have become indispensable in the context of political decision-making. In particular, computer simulations and, increasingly, machine learning models play an important role here. AI models and simulation models pose a double challenge for technology assessment (TA): 1. These forecasting methods are used in the object domain of TA. 2. TA applies these methods itself.

TATuP's Special topic 32/1 (2023) addresses, among others, the following questions: Do options for action, evaluations, forecasts or justifications change through the use of such models? And, on a second level, to what extent does this change technology assessment, insofar as computer-based models are used to assess technologies? Does it change the courses of action considered in TA?

Special topic editors are Andreas Kaminski (RWTH Aachen, HLRS Stuttgart), Gabriele Gramelsberger (RWTH Aachen), Dirk Scheer (ITAS / KIT Karlsruhe).

THANK YOU TO ALL REVIEWERS

for reviewing manuscripts submitted for publication in 2022!

R. Beecroft, B. Bornemann, L. Cordroch, M. Decker, M. Dusseldorp, I.-M. Eichentopf, R. Emmenegger, K. Fischer, S. Gährs, P. Hocke, R. Holzhauer, U. Jürschik, K. Kalmbach, C. Kehl, S. Kersten, J. Knieling, W. Krauß, R. Kreibich, H. Kusch, D. Lang, C. Lecon, L. Leuser, A. Leveringhaus, W. Liebert, B. Lindstädt, M. Mbah, S. Meilinger, M. Meister, G. Müller-Christ, B. Oertel, M. Peissner, J. Pohl, W.-R. Poganietz, R. Popp, R. Rhodius, K. P. Rippe, F. Rudolph, K. Röhlig, M. Schäfer, T. Saretzki, O. Schwedes, S. Schweiger, E. Schwenzfeier-Hellkamp, C. Senkpiel, M. Schreurs, P. Spangenberger, E. Toulouse, J. Tremmel, L. Voget-Kleschin, T. Wäfler, C. Walther, K. Weber, L. Weh, I. Weller, E. Wendeberg, J. Weyer, B. Weyers, Y. Willi

DOAJ SEAL

TATuP was awarded with the DOAJ Seal. This award goes to “journals that demonstrate best practice in open access publishing” (https://doaj.org/apply/seal/). Less than 10 % of the journals indexed there have been awarded the Seal so far. A total of seven criteria must be met for the award, including articles must have permanent article identification (e.g. DOI), metadata must be uploaded to DOAJ on a regular basis, and the journal must be published under a CC license.

SUBMIT ARTICLES AND READ ONLINE

www.tatup.de

STAY UP TO DATE

www.oekom.de/newsletter

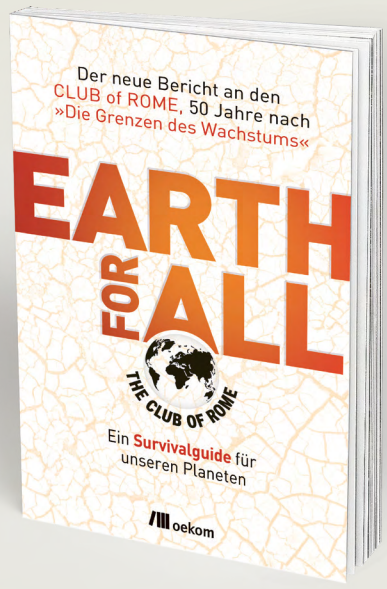
COMMENT, SHARE, LIKE

www.facebook.com/TAjournal

www.twitter.com/TAjournal

www.tatup.de/youtube

Überlebensprogramm für die Menschheit



Der bekannte Think Tank Club of Rome legt in »Earth for All« einen Survivalguide für die entscheidende Dekade der Menschheit vor. Wissenschaftlich basiert zeigen die Autoren Hebel auf für die Bekämpfung von Armut und Ungleichheit und eine nachhaltige Zukunft.

Club of Rome

Earth for All

Ein Survivalguide für unseren Planeten. Der neue Bericht an den Club of Rome, 50 Jahre nach »Die Grenzen des Wachstums«

224 Seiten, Klappenbroschur, mit zahlreichen Abbildungen, 25 Euro
ISBN 978-3-96238-387-9
Erscheinungstermin: 06.09.2022
Auch als E-Book erhältlich

Moderne Selbsttäuschung

Der Urlaubsflug nach Bali, das Steak im Restaurant: Der Psychologe Thomas Brudermann beleuchtet die unzähligen Ausreden, die wir parat haben, wenn Klimaschutz mal wieder zu unbequem ist. Ein fundierter und zugleich kurzweiliger Einblick in die Klimapsychologie.

Thomas Brudermann

Die Kunst der Ausrede

Warum wir uns lieber selbst täuschen, statt klimafreundlich zu leben

256 Seiten, Broschur, mit zahlreichen Illustrationen, 22 Euro
ISBN 978-3-96238-389-3
Erscheinungstermin: 06.09.2022
Auch als E-Book erhältlich

TATuP

ist die weltweit einzige interdisziplinäre Zeitschrift für Technikfolgenabschätzung. Wir fördern Debatten über technologische Innovation, Politik, Gesellschaft und Nachhaltigkeit. In *TATuP* finden Sie...

- Antworten auf drängende Fragen unserer Zeit;
- höchste wissenschaftliche Qualität durch faire Begutachtung und Transparenz;
- 100 % Open-Access: freier Zugang zu allen Artikeln und kostenfreie Publikation.

Herausgegeben vom Institut für Technikfolgenabschätzung und Systemanalyse (ITAS) am Karlsruher Institut für Technologie (KIT)

itas Institute for Technology Assessment and Systems Analysis

TATuP und oekom – passt natürlich!

Mit dieser Zeitschrift halten Sie ein echtes Stück Nachhaltigkeit in den Händen. Sie unterstützen eine Produktion mit hohen ökologischen Ansprüchen. Der oekom verlag ...

- verwendet 100 % Recyclingpapier;
- verzichtet auf Plastikfolie;
- kompensiert alle klimaschädigenden Emissionen;
- druckt in Deutschland – und sorgt damit für kurze Transportwege.

Weitere Informationen finden Sie unter www.natürlich-oekom.de und #natürlichoekom.

oekom