https://doi.org/10.2352/EI.2026.38.3.MOBMU-314

Enabling Factors of International IP Treaties for Unlocking Scientific Publication Image Capture for the Visually Impaired

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Abstract

With 126 signatories as of 2025, the Marrakesh VIP Treaty is one of the most far-reaching international legal treaties and enables blind and visually impaired people and authorized entities acting on their behalf lawful access to copyrighted intellectual property by legitimizing creation of so-called accessible format copies. However, on the explicit topic of image-to-text transformation or text-and-data mining now made possible by advanced vision language models (such as BLIP-2, LLaVA-1.5-7B, Moondream2, Qwen2-VL-2B, and Idefics3-8B), the treaty is silent.

This work provides a comparative analysis of the developments in the tangential legal frameworks of several countries as well as various conference and scientific journal publishing frameworks to highlight the permissibility of visually impaired users of scientific literature to overcome the "book famine" they face. These legal challenges and opportunities are exemplified for the various stakeholders in the scientific publishing domain. Furthermore, the paper explores conflict potentials with data-mining restriction laws and sui generis database rights. The paper ends with an outlook assessing the maturity of the current conference proceedings landscape for enabling legally compliant access to the visually impaired.

Keywords

Legality of Image-to-Text Transformations; Marrakesh VIP Treaty; Accessible Format Copies; Text and Data Mining; AI Training Legality; Assistive Technology; Vision Language Model; Visually Impaired Accessibility; American Disability Act; Visual Impairment Inclusion, Perceivability of Scientific Imagery to Blind

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Introductory Definitions

Visual impairment is defined when an individual is physically blind, and/or suffers a visual ailment substantially impairing the ability to read printed works, and/or is otherwise disabled such that the individual is unable to hold or manipulate a book, thereby making normal reading otherwise impossible [1]. Such individuals fall under the purview and enjoy the benefits of various laws and treaties such that they may create and internationally exchange so-called accessible format copies (henceforth abbreviated as AFCs) [2] in order to access such works without the authorization of the holder(s) of the respective copyrights. They can thereby perceive these contents through various assistive technology tools such as screen readers, tactile interfaces, embossing machines, or image-to-sound transformers.

Stakeholder Constellations in AFC Transformation

Transformation of scientific publication imagery –be it in textual, tactile, or sonified form– requires capture of human perceptible information comprising the work in question. Essential considerations of such scenarios have to be made as to who performs such transformations (i.e. visually impaired individuals (henceforth abbreviated as VIIs) themselves, someone acting on their behalf by implicit order, or the author/publisher/rightsholder of the work themselves). The stakeholders might be even further expanded if a third-party service provider is contracted to transform parts or the entirety of the transformation.

Image-to-Text or Vision-to-Text transformation rely on image capture by a vision language model (VLM) that may be used by itself, or as part of a (digital) service package involving and be run either on the user's own (mobile) device, or on a dedicated assistive tool generally falling under the domain of general product safety regulations (i.e. they are not subject to the increased scrutiny of medical products). Manifestations of assistive tools include screen magnifiers and high-contrast readers, tactile embossing printers, and refreshable tactile displays (which output abstracted forms of the information that are perceivable by touch, similar to the larger three-dimensional tactile maps models as shown in Figure 1). Furthermore, sonification relies on a transformation of images into audible outputs such as melodies, sound harmonics/dissonances, or spoken words.

Figure 1. *Tactile Maps in Berlin. Top left: Berlin City Center tactile map (1:2000 scale) with raised, enlarged models of landmarks like the Brandenburg Gate or the Reichstag (1:100 scale). Audio tracks are triggered by inbuilt sensors [3]. Top Right: North-South View of the Tacile Map of the Berlin Museum Island by Egbert Broerken [4]. Bottom: Enlargement of the Berlin Museum Island Tactile Map with Braille lettering visible on the roofs, such as the Pergamonmuseum. This 150 × 70 cm bronze model was completed in 2011; models such as these take about nine months to complete [5]. Photography by the primary author.*

Beyond the parties directly involved in the transformation process, payors such as disability insurances, government agencies, or philanthropic entities might also play a role in the remuneration of the transforming entity, should VIIs not elect to or not be able to create their accessible format copy themselves.

Legal Framework & Stakeholders

Primarily, both the access and transformation of works into accessible format copies is governed by intellectual property (IP) law and associated international treaties; however, this may be flanked tangentially in the domains of database, data protection, artificial intelligence law, as well as more general conventions on human rights.

Intellectual Property Law

While concepts like patents can be traced back to medieval legal customs in the form of *litterae patentes*, modern definitions of IP protection mechanism were internationally formalized in the Paris Convention of the Protection of Industrial Property, initially signed by eleven nations on March 20th 1883 [6]. After various revisions and amendments, currently 181 nations have signed or acceded to this treaty. Besides establishing a "common vocabulary" on IP concepts, the treaty sets forth the essential protective legal means which membership states must afford to IP rightsholders — regardless of domicile or citizenship status— such as the right of priority, recognition of authorship, sovereign filing and registration procedures, as well as legal provisions for and enforcement of licensing. Protection of the works and rights of authors thereto is governed through the concept of copyright as defined in the Berne Convention for the Protection of Literary and Artistic Works of 1886, which, as of today, has come into force in 186 nations [7]. Crucially, this treaty establishes the "Berne Three-Step Test" which sets forth that exceptions to copyrights may only apply to certain special cases, may not conflict with the normal exploitation of the work by the rightsholder, and may not incur unreasonable prejudice to the legitimate interests of the author [8], [9]. A geographical representation of both treaty adoptions is depicted in Figure 2:

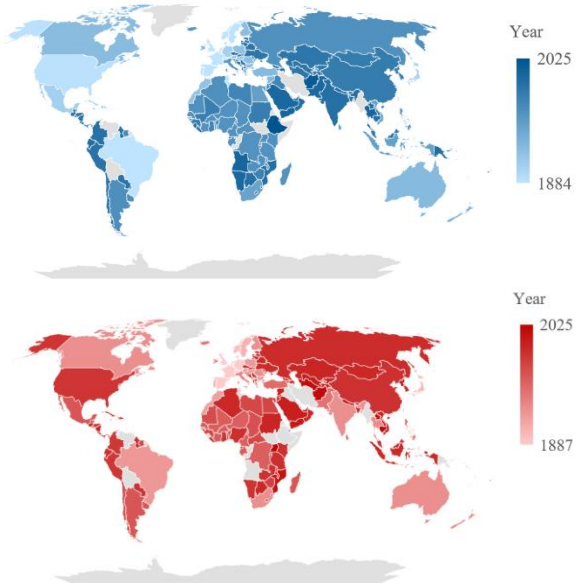

Figure 2. *Signatory States to the Paris Convention (top) and the Berne Convention (bottom). As of 2026, only 18 and 15 nations have not signed or acceded to the Paris or Berne Convention respectively, four and three of which, respectively, however are members of the World Trade Organization and are thereby similarly obliged through the TRIPS agreement [10].*

Through the adoption of the 1996 WIPO Copyright Treaty, copyright is further transposed to the digital network environment [11] by requiring member states to provide the legal means to sanction circumvention of technical prevention measures against copying [12] and removal of rights management information metadata from copyright protected files [13], as well as to afford authors exclusive rights to control distribution of their works to the public through wire and wireless means [14]. Critically to this article's context, "storage of a protected work in digital form in an electronic medium constitutes a reproduction" [15].

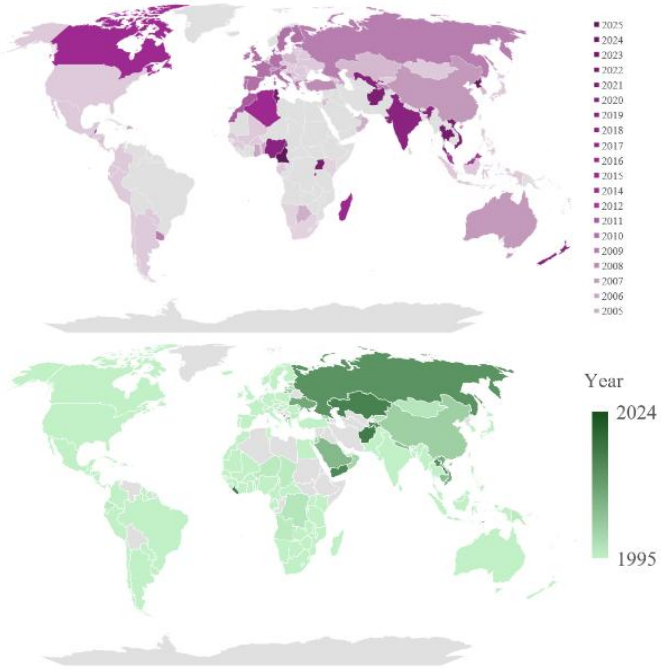

Figure 3: *Signatory States to the WIPO Copyright Treaty (top) and the TRIPS Agreement (bottom). As of 2026, 77 and 27 UN member states have not signed the WIPO Copyright Treaty or TRIPS Agreement, respectively.*

The aforementioned treaties provide an international framework as to how intellectual property concepts are to be manifested into national law in the various member states [16]. Ratification, enforcement, and registration procedures remain sovereign responsibilities of the various nations, and individuals have to follow the various IP and tangential laws in order to pursue their rights, apply for registration for the IP forms, where applicable, or seek adjudication in the respective national court systems.

Scientific publications also fall within the domain of copyright, which (unlike patents or registered trademarks) is enforceable *ab initio*, meaning that no formal registration with a government authority is necessary for protection beforehand. This affords authors the rights to recognition of authorship, to publish, to control/delegate distribution and/or broadcast, to translate, to enable public access, as well as provisions on rental and licensing, and, last but not least, the right to make reproductions as well as transforming their creations into audiovisual works. The Berne Convention affords a minimum copyright protection of 50 years for after the author's death [17] and ≥ 25 years after the creation of applied art and photography [18]. If a work is published anonymously or under pseudonym, copyright remains in force at least 50 years after the date when the work was made available to the public [19].

Under normal circumstances and if legally pursued by the rightsholder, through a copyright collective, or by a non-practicing entity, copyright violations may incur penalties afforded under national law, enabling the claimant to seek various means of compensation from the infringer and order refraining from future violations. If found liable, the infringer might be liable for pecuniary compensation [20] (i.e. surrender of profits from lost licensing, sales, or market displacement) or be subject to enforcement remedies [21], such as corrective measures like claim to destruction, recall, release of copies, right of information (f.e. on origin of copies such as involved manufacturers, distributors, pricing, trade, etc.), or even prominent public disclosure of associated court verdicts. An excerpt of legal consequences of copyright infringement is tabulated below:

Table 1: List of Punitive Measures for Copyright Violations in Selected Countries

Jurisdiction	Primary Civil Penalties (Damages)	Criminal Penalties (Prison/Fines)	Administrative & Specific Measures
Brazil	If sales are unknown, up to 20x the value of the work.	2 to 4 years imprisonment plus fines for commercial gain.	Seizure and destruction of all infringing copies and manufacturing equipment.
China	Statutory damages up to 5M RMB. Punitive damages (1-5x) for serious "bad faith."	Up to 10 years for "huge" illegal gains or "serious" circumstances.	NCAC Fines: Rapid administrative fines that don't require a full court trial.
EU (General)	"Unjust Enrichment": Disgorgement of all profits made by the infringer.	Member state discretion; typically 3 to 5 years for commercial scale.	Cross-Border Enforcement: Infringement in one EU state can be tracked across the entire EEA single market.
India	"Account of Profits" or "Exemplary" (punitive) damages for flagrant acts.	6 months to 3 years; mandatory minimum fine of ₹50,000.	Police can seize infringing material without a warrant in certain IP cases.
Japan	Presumed damage based on the amount of a "reasonable license fee."	Up to 10 years imprisonment or 10M JPY fine.	Dual Liability: Both the employee and the company are prosecuted simultaneously.
Russia	Statutory compensation from 10k to 5M RUB or 2x the value of the copies.	Up to 6 years for "large scale" acts by an organized group.	Repeat offending websites can be blocked permanently by Roskomnadzor.
Saudi Arabia	Fines up to 250,000 SAR and payment of compensation.	Up to 6 months imprisonment for repeat/severe offenses.	Business Closure: Authority to shut down the offending establishment permanently.
Switzerland	Damages limited to lost profit or a "reasonable royalty."	Up to 1 year (standard) or 5 years (commercial) prison.	Private Use Exception: One of the few places where downloading for personal use is mostly legal.
United Kingdom	Damages based on "Actual Loss" or "Account of Profits." Costs are usually capped in IPEC.	Up to 10 years for commercial-scale online or physical piracy.	Injunctions: Direct court orders to ISPs to block infringing websites (e.g., pirate streams).
United States	Statutory damages: US$ 750-30,000 per work. Willful infringement: up to US$ 150,000.	Up to 5 years (10 for repeats) + fines up to US$ 250,000 per offense.	Attorney's Fees: Winners often recover all legal costs. "Innocent" infringement can drop to US$ 200.

Within regular IP law, there are various means of copyright limitation, such as Fair Use [22], [23], the idea-expression dichotomy [24], and the *scène-a-faire* doctrine [25, pp. 105-106]. Partial excerpts may be permitted for educational [26], instructional [27], or research purposes [28], as well as for public safety and judicature [29]. For communication in public libraries [30], museums and archives [31], entire copies may be made available. Public performance of a work may also be possible without rightsholder authorization if both the audience is restricted to a delimited circle and doesn't pay, and performers do not receive special remuneration. Similar exemptions exist if the performance of the work occurs in welfare service institutions [32].

Furthermore, through the first sale doctrine [33], material interests are considered exhausted upon sale [34]; therefore, a buyer may create copies for him- or herself for private use [35] after purchase.

Database & Computer Program Directives

In the context of processing larger works repositories, database regulations might come into effect. Under the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) [36] and the WIPO Copyright treaty [37], distinctions are made between creative and non-creative databases. The curated structure "by reason of the selection and/or arrangement" of creative databases as well as its content entries each enjoy regular copyright protection akin to artistic creations. In contrast, the entries in non-creative databases usually lack creative originality and expressiveness required of their creator (f.e. the entries in a phonebook) and therefore do not enjoy copyright protection. Still, *sui generis* rights afforded to non-creative databases in many jurisdictions such that the investment in their collection, verification, and presentation of existing data are protected for a duration 15 years after the database's completion [38], [39, pp. 6-7]. Owners of online content may therefore prohibit automated data-capture and reutilization of substantial parts of their works in a database (e.g. for the purpose of image-to-text transformation or sonification) through either machine-readable robot exclusion protocols and/or by contractual means [40].

It is noteworthy that, in contrast to residency requirement forfeitures otherwise set forth since the Paris Convention, the EU database directive stipulates that individual creators of non-creative databases must be EU citizens or have their habitual residence there to enjoy *sui generis* rights. Likewise, corporate entities must have registered office, central administration or principal place of business in the EU to enjoy *sui generis* rights to their non-creative databases [41].

Outside the United States (which doesn't preclude software from patentability [42]), the expression of code (assumed here to be in non-accessible format) often enjoys protection such that unauthorized reproductions beyond backups [43], decompilations with the aim to achieving systems interoperability [44], or for the purposes of observation & testing [45], may all be restricted by the developer or rightsholder [46]. In this regard, rulesets like in the EU Computer Programs Directive present a potential conflict between the needs of a VII to access or modify software code in order to create accessible format copies, and the rightsholders' aforementioned exclusive control of copies and literal expression of their software code. This thereby exposes the VII or authorized entity to possible direct infringement claims on the grounds of violating the author's production rights.

Data Protection Regulations

Directives such as the Russian Federal Law 152-FZ, last amended to include data localization requirements in 2015, the first amendment of the Japanese Act on the Protection of Personal Information (APPI) of 2017, the EU General Data Protection Regulation (GDPR) of 2018, the Brazilian General Data Protection Law (LGPD) of 2020, the Chinese Personal Information Protection Law (PIPL) of 2021, the Saudi Royal Decrees No. M/19 of 9/2/1443H in conjunction with No. M/148 of 5/9/1444H of 2023, the Swiss New Federal Act on Data Protection (nFADP) of 2023, or the Indian Personal Data Protection Act (DPDPA) whose business compliance deadline is set to mid-2027, preclude personally identifiable data (PID) from leaving national or supranational territory unless specified conditions apply [47]. This is depicted in further detail for a few selected countries below:

Table 2: Legal Exceptions to PID Localization Requirements for Selected Jurisdictions.

Country/ Region	Regulation(s)	Countries/Institution/Organization providing equivalent protection	Compliance Obligation of the Data Controller to provide equivalent protection	Exchange Cooperation between Police & Intelligence Services	Authorization by domestic supervisory authority	Transfer required for life protection or physical integrity of affected individual	Commitment through international cooperation agreement	Specific & Highlighted Consent by Affected individual	
Brazil	LGPD	☑	☑	☑	☑	☑	☑	☑	
China	PIPL	☑	☑	☑	☑	☑	☑	☑	
European Union	GDPR	☑	☑	☑	☑	☑	☑	☑	
India	DPDPA	☑	☑	☑	☐	☑	☑	☑	
Japan	APPI	☑	☑	☑	☐	☑	☑	☑	
Russia	152-FZ	☑	☐	☐	☑	☑	☑	☑	
Saudi Arabia	No. M/19 of 9/2/1443H + No. M/148 of 5/9/1444H	☑	☑	☑	☑	☑	☑	☑	In comparison to the explicit opt-in approach in many countries, the California framework relies on an out-out choice by the individual (with the exception for minors) thereby preventing the counterparty to otherwise collect PID by default. The CCPA expects contractual provision that international parties provide equivalent data protection levels and transparency.
Switzerland	nFADP	☑	☑	☑	☑	☑	☑	☑	
United Kingdom	UK GDPR, Data Protection Act of 2018, Data (Use & Access) Act of 2025	☑	☑	☑	☐	☑	☑	☑	
United States (California)	CCPA + CPRA	☐	☑	☑	☑	☑	☐	☐	

As demonstrated, countries often determine so-called adequacy lists for countries which were deemed to provide the same adequacy requirements with regards to the protection of PID as the issuer's own such that restrictions on data flows are thereby lifted. This may serve as promising starting point for assessing feasibility to cross-border data transfer.

Artificial Intelligence Regulations

On the highly dynamic field of Artificial Intelligence (AI), legislation from various jurisdictions is emerging likewise. One of the earliest examples is the EU AI Act of 2024 [48] which adds safety protection and quality considerations to the usage and passage of information to AI and large-language models. In particular, the act classifies AI applications that are prohibited (such as those intended for social scoring, remote real-time biometric surveillance in public spaces, or manipulation of cognitive human behavior) [49], high risk necessitating entry in an EU database (such as when being used for critical infrastructure management, education & vocational training, law enforcement, etc.) [50], limited risk requiring user awareness (such as those capable of image, sound, or video manipulation) [51], minimal risk (i.e. with dedicated applications such in spam filters or for video games), as well as exempted applications (i.e. for national security, as well as for solely scientific R&D purposes) [52]. Providers of general-purpose AI models have to disclose information on their transparency, IP protection &

copyright compliance [53], as well as safety & (cyber)security measures. They also have to establish and maintain technical documentation of their model, including a summary of the training data [54], unless when operating on free and open-source business models [55].

On the issue of training data, the EU AI Act intersects at this point with the text & data mining (TDM) restrictions available to rightsholders in copyright law [56] and the database directives as mentioned previously. Adjudication on the critical question whether creation of AI training data based on copyrighted work may already constitute a copy is currently still pending. For instance, in the on-going US federal class-action lawsuit *Anderson et al. v. Stability Inc.*, the artist plaintiffs assert that AI-generated images violated copyright as the defendant's models were trained on their artwork [57]. During the pre-discovery phase of this case, several of the plaintiff's claims have survived motions to dismiss, such as that the defendants' web-scraped datasets permit removal or disfigurement of copyright management information in violation of the US Digital Millennium Copyright Act [58], that copyright violations are possible if protected training images could be output by the defendant's resultant model through precise prompting, or that distribution of the AI model itself to third parties could conflict with the plaintiffs material interests, i.e. infringement upon the latter's right to distribute their own works [59]. The trial is scheduled to begin in September 2026, and a verdict might provide orientation whether VLM training data incorporated in AI-based assistive technologies might face further IP considerations. In parallel, the verdict from the class-action lawsuit *Bartz et al. v. Anthropic PBC* established that LLM training based on legally acquired book copies falls under concept of fair use [60]. Here, AFC creation or procurement through Marrakesh treaty instruments might align with legitimate acquisition of the work. Cases like these therefore merit continued attention in order to further delineate legitimacy of AI-based assistive tool use when transforming scientific imagery for the benefits of VIIs.

Human Rights Conventions & Treaties

Prior to the formation of the United Nations and its 1948 Declaration of Human Rights, special treatment of VIIs was already afforded through the 1884 Congress of the Universal Postal Union (UPU) by treating tactile dot embossed print matter —which by design is significantly heavier than common print paper or stationery— as regular letters, thereby avoiding higher postage commonly charged for packages. By 1920, a worldwide postage rate cap for such materials was agreed upon and, by the subsequent decade, the weight limit for blind literature deliveries was raised progressively. By 1952, UPU members decided to ship tactile character literature for free and the agreed upon *cécogramme* mark furthermore allows complimentary mailing of sound recordings (since 1964) and of digital storage devices (since 2006) between VIIs, as well as to VII and/or to official support institutes, in 192 countries.

Figure 4. *Cécogramme Label of the Universal Postal Union.*

With the 1950 Agreement on the Importation of Educational, Scientific and Cultural Materials (Florence Agreement), the United Nations set forth that contracting states shall both enable importing licenses [61] and refrain from levying customs duties [62] for articles for the blind (i.e. "Books, publications and documents of all kinds in raised characters for the blind" as well as "other articles specially designed for the educational, scientific or cultural advancement of the blind […]") [63]. Going beyond imports, the 2007 UN Convention on the Rights of Persons with Disabilities (UNCRPD) establishes that persons with disabilities have the freedom "to seek, receive, and impart information and ideas" [64] in conjunction with the right to education [65], participation in cultural life [66], as well as participation in political and public life [67]. The creation and exchange of accessible format copies —even mentioned *ad verbatim* in Art. 30 Sec. 1 lit. a — can be construed as obligatory prerequisite in order for VIIs to exercise these rights.

The golden standard for inclusion of VIIs is established through the Marrakesh VIP Treaty of 2013 and, at time of publication of this paper, has been adopted by 126 countries [68]. The treaty defines the intended beneficiaries as someone who is blind, afflicted by a continuous "visual impairment or reading disability", or is otherwise unable to "hold or manipulate a book, or lacks the ability to focus or move the eyes to the extent that would be normally acceptable for reading" [1]. Treaty beneficiaries (or someone acting on their behalf) are entitled to create and internationally exchange [69] accessible format copies which serve to give them "access as feasibly and comfortably as a person without visual impairment or other print disability" all without permission of the work's rightsholder [70]. Furthermore, the treaty sets forth that providing "adaptive reading or information access to beneficiary persons on a non-profit basis" may be performed by government-established or government-recognized authorized entities if these designate VII accessibility as "one of [their] primary activities or institutional obligations" while additionally limiting AFC provision to "beneficiary persons and/or authorized entities" [71]. The concept of the AFC is mirrored both in other treaties [72], [73] and national IP law of many countries [74], [75]. As the Marrakesh VIP treaty doesn't mandate a specific national registration process [76], authorized entities might domestically manifest themselves through private or government-funded institutions. Examples of the latter are the US National Library Service for the Blind (established by the 1931 Pratt-Smooth Act and specifically copyright exempted by the 1996 Chafee Amendment [77]) or the *Deutsches Zentrum für barrierefreies Lesen*, a state-subsidiary of the Saxon Ministry of Science, Culture, and Tourism in Germany [78]. Lastly, the treaty obliges contracting parties to set in place legal protection measures and remedies for assistive technology usage when the intended user encounters or has to circumvent technological copyright protections of works. Still, the crucial subject matter of image-to-text transformation or sonification approaches is not mentioned by name in the treaty text; only an indirect mentioning of "people on behalf of beneficiaries" could be construed as linking to operators of assistive technology platforms.

Accessibility Law

In light of the technical challenges in creating AFCs (described in more detail in a subsequent section), several countries have recently passed legislation suggesting —or sometimes even obliging— specific author groups (generally public employees) to adhere to certain guidelines to improve accessibility of their

electronic works to assistive tools or preclude the latter from being subjected to TDM restrictions as summarized below:

Table 3: Summary of Accessibility Legislature on Assistive Tech Compatibility Mandates and Publisher TDM Restriction Exclusions from Selected Countries.

Country	Key Law(s)	Public Employee Mandate	Private Author / Publisher Context	Enforced Since / Effective Date
Brazil	LBI (Law 13.146)	Strictly Mandatory. Universal design required for all research.	Mandatory. Civil rights law requires all websites/content to be accessible.	Janunary 2016 (revised 2025)
China	Barrier-Free Law	Mandatory. Public info must be accessible.	Strictly Encouraged. Market-led "gradual" transition for commercial sites.	September 2023 (active 2026)
EU	EAA & WAD	Strictly Mandatory. Every public output must be tagged.	Market Mandatory. Journals cannot sell in the EU unless accessible.	June 2025 (enforceable)
India	RPwD Act 2016	Mandatory. All public-facing content must be in accessible formats.	Mandatory. 2025 SEBI/MIB circulars force private platform compliance.	2016 (stricter rules in 2025)
Japan	Discrim. Elim. Act	Mandatory. Public bodies must provide accommodations.	Mandatory. Private businesses must provide "Reasonable Accommodation."	April 2024 (active)
Russia	Fed. Law 419-FZ	Mandatory. All state digital services must be accessible.	Emerging. Focus on "Information Aggregators" and "Intermediary Platforms."	Jan 2016 (update Oct 2026)
Saudi Arabia	SDAIA Policy	Mandatory. All Gov/SDAIA research must be accessible.	Expanding. Vision 2030 requires WCAG 2.1 for all digital "Public Services."	2020 (Vision 2030 Target)
Switzerland	BehiG (DDA)	Strictly Mandatory. Covers federal/public university employees.	Market Mandatory (2027). Private commercial services must be accessible.	2004 (Digital Rev. January 2027)
UK	PSBAR / Equality Act	Strictly Mandatory. Public university staff must meet WCAG 2.2 Level AA.	High Pressure. "Reasonable adjustments" required to avoid civil lawsuits.	Sept 2018 (WCAG Level 2.2 2024)
USA	ADA Title II & III	Strictly Mandatory. "Accessible by Default" for public universities.	Market Mandatory. High litigation risk under Title III for inaccessible content.	1990 (Rule Update April 2026)

Depending on jurisdiction, enforcement may rely on governmental supervisory authorities or on the private right of action principle, whereby individuals or non-governmental organizations (such as the European Disability Forum [79]) act as watchdog and file lawsuits to seek adjudication. While some countries provide mediation opportunities (like the Swiss Cantonal *Schlichtungsstellen* [80] or the Federal BGC Arbitration Service in Germany [81]) to resolve grievances out-of-court, or alternatively might intervene through short-duration remediation orders by supervisory authorities (such as the Office for Civil Rights at the US Department of Education [82]), consequences of persistent non-compliance may include fines [83] (Ontario even provides for a daily fine of up to CAD$ 100,000 per day of willful and deceptive corporate non-compliance [84]), compensation payments to affected plaintiffs, removal of governmental funding [85], blacklisting in government procurement bids (i.e. suspension & debarment pursuant to [86] in conjunction with [87]), or even product recalls or bans of affected products or platforms [88]. For grave instances of non-compliance with national regulations aligned to the EAA, Ireland even has an imprisonment penalty of up to 18 months [89].

Social Law & Income Tax Benefits

National legislation provides further details on definitions and rights of VIIs, and, depending on country, even the legal basis for the entitlement to compensation for technical accessibility to AFCs. The German equalization levy shall be used here to exemplify the value streams that aim to fund the inclusion of VIIs.

Social Code IX mandates German companies with at least 20 employees to hire a minimum quota of 5% of disabled workers in their workforce [90]. Non-compliance results in yearly compensation payments for every position that is not filled by an employee with a registered disability and progressively increase with a dropping disability quota [91]. These funds, together with additional local, state, and federal tax revenue flow to the municipal Offices for Social Care Provision (*Versorgungsämter*, institutions comparable to the California Department of Rehabilitation) which then disburse alleviating measures (such as auxiliary aids and workplace adaptations) depending on an applicant's registered degree of disability [92]. While there is no threshold percentage for VIIs to qualify, grant prospects are on an individual basis, and, considering budgetary nature, one-time disbursements (such as for straight purchases of devices) appear preferred over continuous payments (such as for a monthly service subscription or for a budget

of AI tokens intended for image-to-text transformations). Furthermore, German VIIs can claim a yearly disability income tax deduction of €7,400 [93] or claim itemized deductions for extraordinary expenses [94].

The German system therefore works on a basis of disbursement through a government entity and not primarily on the individual negotiation outcome between a visually impaired employee and the employer. Regardless of VII income, German states furthermore pay out monthly Visual Impairment Support *(Sehbehindertengeld)* depending on institutionalization and concurrency of other disabilities [95]. Furthermore, there is a federal income-dependent supplement *(Blindenhilfe)* [96] to top-up income and purchase of visual-impairment aids or services in case of financial duress.

Besides income tax, sales or value-added tax exemptions are another tool sometimes afforded to VIIs: The US state of Virginia, for example, completely exempts all items sold to its Department for the Blind and Vision Impaired —an authorized entity pursuant to [71]— from its state sales tax [97].

Technical Challenges in AFC Transformation

One of the frontier challenges to transforming imagery is the uncertainty of inclusion of image descriptors or programmatic metadata (referred to as "alt text" in MS Office products [98]) either by the author or by the editor acting on the former's behalf. Regardless of the approach of transforming imagery (i.e. Image/Vision-to-Text, Image-to-Tactile, or Image-to-Sound/Sonification), the question arises whether the viewer should begin perception of the visual at a specific starting point and then follow a specific vision path, or whether the subsequent experience may be at the viewer's discretion with regards to both pathway(s) and directionality. If the author intended that the image is to be experienced along distinct sections, delineation of their boundaries must also become detectable to the visually impaired viewer or to the utilized assistive technology.

Additional challenges may arise during transformation of scientific publication images when the latter consist of collages of different visuals (be it tables, diagrams, (hand) drawings, graphs, or embedded photography), or when it is uncertain whether one part of an image is to be in the foreground over another. This gets further compounded if different layers or sections of such images are intended to be read in conjunction to another or if these are in logical linkage to another (f.e. through text-filled overlay arrows). In such instances, assistive technology needs to able to detect these exceptions to the otherwise discrete image boundaries which authors or modern text processors might have already affixed previously. If the vision flow amongst image element splits into multiple branches, these challenges get even further exacerbated as now the assistive tool furthermore needs to navigate, and, if so desired by the viewer, also be able to backtrack the vision paths taken.

When monotone images lack sufficient dynamic range, or when colors lack sufficient contrast or are so plentiful, images cannot be readily or independently captured without the help of a vision capable human assistant [99]. Similarly, reduction of image sections for manifestation on a refreshable tactile display (i.e. expression through different heights, surface patterns or vibrotactile effect that the machine can produce) [100]. Once images become three-dimensional, abstractions of depth or overlay layer complexities can become especially challenging if no axis dimension information is provided by the author.

Status Quo in the Conference & Scientific Journal Landscape

Beyond the aforementioned legal framework arising from statues and international treaties, organizers of conferences and publishers of scientific journals are afforded the ability to further regulate accessibility contractually. Relevant contractual parties in this context are authors (who might be obliged to adhere to certain accessibility standards set forth individually by the publisher/conference organizer, or to those aligned to the legal mandates or regulations of a specific country) as well as content users, such as direct customers who consume online materials under adhesion contract (clickwrap, browsewrap, scrollwrap, and/or sign-in-wrap).

If VIIs seek to use their own or third party-supplied assistive tools (such as VLMs), special care must be afforded by the publisher such that this type of automated image capture is not misinterpreted as illicit webscraping or text-and-data mining that would otherwise be blocked by the host server.

Several standardized guidelines exist to aid authors and publishers in making their works accessible to VIIs.

W3C Web Content Accessibility Guidelines

Stemming originally from the Web Accessibility Initiative (WAI) brought forth by World Wide Web Consortium (W3C) in 1997 [101], the Web Content Accessibility Guidelines (WCAG) are now in their latest version as of February 2026 [102] and are one of the most commonly recommended rulesets aiming for formats which are compatible to assistive tools used by VIIs.

With regards to publication imagery, the primary hallmark of WCAG expectations is that "All non-text content that is presented to the user has a text alternative that serves the equivalent purpose" [103]. Furthermore, 3-D visualizations are to feature descriptions containing information on spatial orientation and collages are feature labels specifying reading path and panel boundaries [104]. Since the release of version 2.0 in 2008, WCAG requirements are structured in three levels: Level A aims for technical access of online contents by VIIs and includes mandates such aforementioned alt-text for images and provision of basic keyboard navigation of websites. Level AA furthermore specifies color contrast ratios, and consistent navigation menus with clearer focus indicators for keyboard users. Level AAA, aimed prominently at high impact, authentication-linked and task-oriented portals for VIIs (such as for tax filing, online banking, or medical prescription management) as well as at educational contents, intends to provide the most advanced features such as mandatory sign language interpretation for videos, explanation of all idioms and abbreviations, minimum button sizes, even higher color contrast requirements, and text resizeability to 200% without loss of content or functionality.

WCAG, either by ad verbatim reference or by adoption of aligned national standards, is mandated by law in many countries: For instance, WCAG 2.1 Level AA is closely mirrored in the EN 301 549 standard "Accessibility requirements for ICT products and services", which on the basis of the EU Web Accessibility Directive (EU 2016/2102) in conjunction with the European Accessibility Act (EU 2019/882) came into force in the European Union in June 2025 and mandates compliance for government entities [105]. References to WCAG Level 2.1 similarly exist in Title II of the US American Disability Act which is coming into force on April 26, 2026 for large public entities serving populations of at least 50,000, with smaller institutions having another year of grace period [106]. This has clear impact on the production of new digital documents by members of the scientific community who work at public universities,

governmental research centers, or who work in government-funded research projects [85]. WCAG stipulations in varying forms are visualized below:

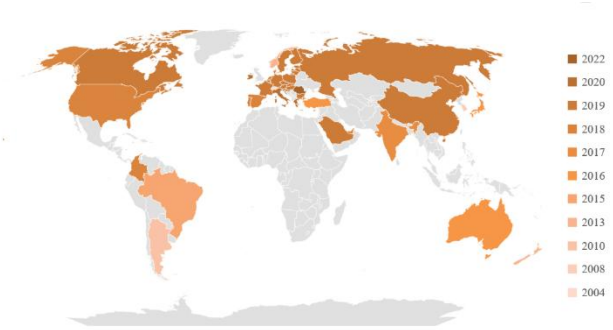

Figure 5. *Legal Stipulation for WCAG Adoption for 46 Selected Countries.*

EPUB3 & Digital Accessible Information System (DAISY)

Another prominent standard is the XML-based Digital Accessible Information System (DAISY) which was developed in the mid-1990s and aims to provide VIIs with a structured means of navigation amongst various document sections and footnotes [107]. With its 2011 release, Electronic Publication, version 3 (EPUB3) aims to bring DAISY principles to web technologies such as HTML5, CSS3, and JavaScript [108]. Content becomes reflowable to fit any screen size, media overlays provided for narration with corresponding text are highlighted, and complex mathematical formulas are to be expressed through the MathML format [109]. Inclusion of rich accessibility metadata (such as Accessible Rich Internet Application (ARIA) [110]) aims for better integration of assistive tech.

Adoption by Conference Organizers (IS&T Exemplification)

To highlight the regulatory leverage held by conference organizers, the Society for Imaging Sciences and Technology provides in its author publication template that imagery is to have a minimum resolution of 300 dpi [111] which exceeds many commercial tactile embossing offerings operating in the 20-100 dpi tactile resolution range [112].

Authors provide their works to the Journal of Imaging Science and Technology, the Journal of Perceptual Imaging (JPI), and/or the Electronic Imaging Conference Proceedings under the Creative Commons CC BY 4.0 International License [113, p. 2], which permits viewers to explicitly shift works across all media and formats (such as creating a braille-ready file, DAISY-style audiobook, or a sonified version of the work, etc.). Likewise, this license standard prohibits the use of technical protection measures to lock out potential assistive tools that might otherwise be miscategorized as TDM.

While the use of this license template broadly alleviates legal risks for visually impaired readers to create AFCs of IS&T works, no hard accessibility requirements such as WCAG Level AA or above are stipulated as of the time of this publication. Considering the high level of detail and complexity commonly encountered in scientific imagery at Electronic Imaging conferences, it may be assumed that venues such as these are amongst the final frontier with regards to assistive technology accessibility.

Adoption by Scientific Journal Publishers

Under the premise of "born accessible" workflows [114], major publishers of scientific journals such as Elsevier [115], [116], Sage Publications [117], Springer Publishers [118] and Taylor & Francis [119] have moved to converting journal articles to EPUB3 and/or WCAG.

Accessibility monitoring tools such as the open source Pa11y [120] are suggested by DeGruyter, Springer, Taylor & Francis, as well as the Open Educational Resources space, to authors to check accessibility of their works. Elsevier and Oxford University Press are examples which even offer dedicated website services for AFC requests [121], [122] and the former also works together with the AccessText Network from the Association of American Publishers [123] through which institutional Disability Student Services Officers can request AFCs on behalf of beneficiaries.

Karger Publisher's accessibility guidelines for authors may be counted towards the more advanced in the publishing landscape. Indeed, they provide significantly more detail with regards to structure and contents of alt-text for visuals (vision flow guidelines, overall brevity & trend highlighting, no bullet points, full stop terminators, etc.), and mandate use of scalable vector graphics, as well as avoidance of using solely color to highlight distinguishable data in order to rather use texture-fills [124]. Screening of alt-text also has become part of their peer review process.

Conclusion

While the Marrakesh VIP Treaty provides significant leeway for visually impaired individuals to create accessible format copies, overlapping conflicts with local data protection and software laws might still remain in the context of international transfer of personally identifiable information or during the creation of copies based on what could be construed as software code. Indeed, the very definition of visual impairment of a treaty beneficiary person, as well as that of the accessible format copy are heavily oriented towards the classical paper-based manifestation of works of literary and artistic works. Modern digital assistive tools (be they image-to-text vision language models, image-to-tactile embossing, or image-to-sound sonification approaches) can encompass novel AI-based approaches which may reach the limits of current terminology and conceptual basics from intellectual property law: An author, a group of co-authors and, by extension, even the author of a derivative work must be natural persons in order to defend IP rights or in turn assert claims in court. Liability constructs involving AIs are still finding their way into case law and statutes. Legal instruments must therefore continue to evolve in order to protect the rights of all stakeholders involved and set the basics of their mutually beneficial co-existence in society.

The legal, regulatory, and contractual framework governing transformation of scientific imagery is summarized below:

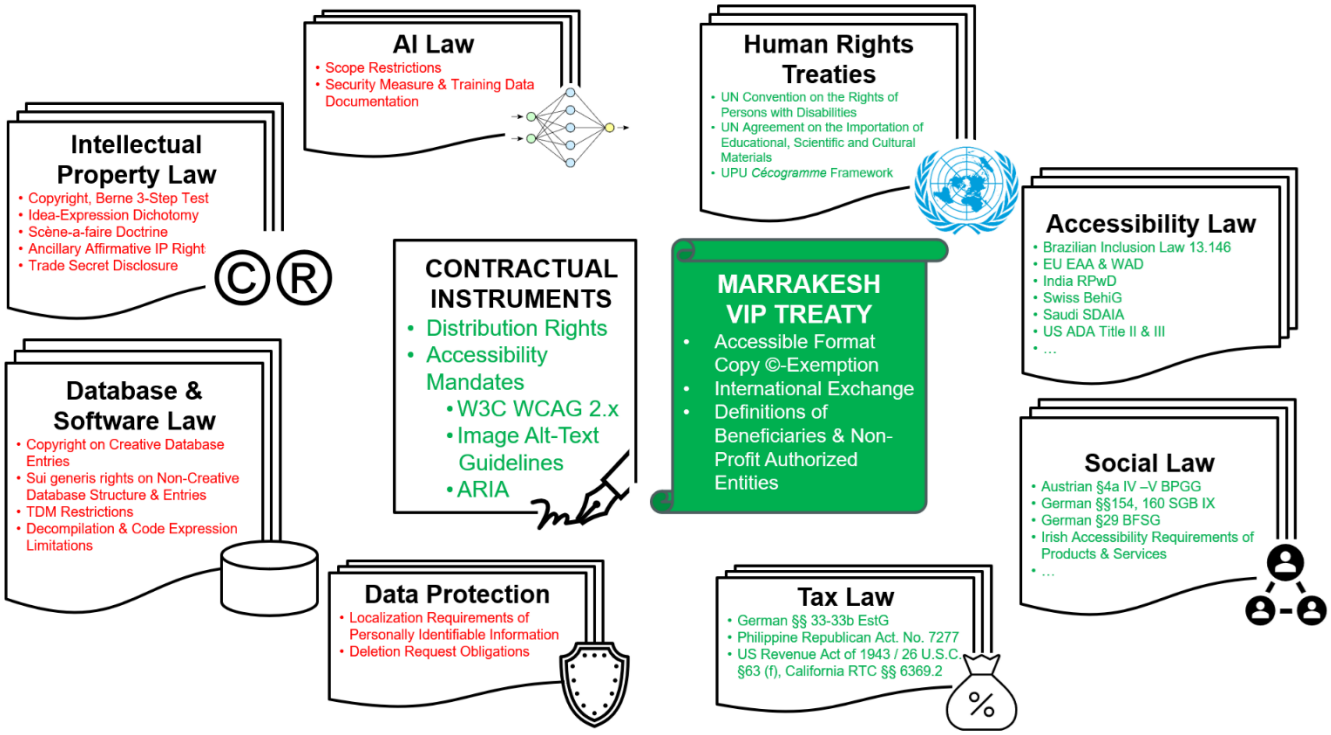

Figure 6. *Legal Framework Governing Scientific Imagery Accessibility by VIIs or Authorized Entities as addressed in this article. Regulations and laws that have a more exclusionary nature are highlighted in red; affirmative rights in support of VIIs are highlighted in green.*

Adaptation and local enforcement of these enabling factors is inherently subject to political pressure as balancing integration of VIIs at one point or another also warrants consideration of the associated costs, given finite resources in society. Considering the momentum in technological advancements —in particular in the field of VLMs— it is imperative that discussions on the topic are not hampered by outdated or one-sided preconceptions and achieve reasonable and objective advancements of the legal domain as well. The guiding principles of treaties like the UNCRPD which enable visually impaired and other disabled individuals to participate in society also demonstrate the inclusiveness, tolerance, and also empowerment that the latter is able to bestow. Be it due to pathology or accident, visual impairment onset is possible in all stages of life, still affects sizeable proportions of the global population, and also causes a sizeable estimated annual global productivity loss of about US$ 411 billion purchasing power parity [125]. Therefore, general preparedness is beneficial to both the affected as well as relatives, friends, and coworkers —regardless of whether the impairment is permanent or only temporary.

Impact of Findings on the Scientific Publication Stakeholders

While the legal requirements for more integration of VIIs are evolving in many countries, the already intense workload faced by both authors and publishers of scientific publications needs to be highlighted equally so. In times of limited resources, increased adjunct workloads, in addition to time and quality pressures, researchers face ever intensifying constraints to publish to every stakeholder's satisfaction and achieve both personal and societal advancement. This paper therefore is not intended to admonish writers whose work might not adhere to the full spectrum of accessibility guidelines.

It is the genuine hope of the authors of this paper that gaining more familiarization with perceptive challenges —and indeed those faced by VIIs pose an extreme in this regard— further enhances the comprehension and awareness of authors about their own topic and that this perceptiveness increases the integral robustness in both their writing as well as scientific image generation skillset.

Publishers are faced with the delicate act of balancing speed, ease, and cost of publication of scientific findings with the integrative needs of VIIs set forth by accessibility law and regulations. While VII needs are important, a scenario in which the efforts of creating accessible media become prohibitive and thus further exacerbate the nature of the sometimes derided as "pay-to-publish" world, would likewise entail serious consequences for the advancement of science. Still, publishers can enable authors by providing accessibility compliance checking tools, or by at least providing clear image generation instructions in their publishing guidelines. If scientific publishers, together with academia and industry, can together agree to or lobby for established levels of continued training of existing and aspiring researchers on accessibility formats, preparedness may be streamlined such that authors may focus more on their research and creative processes, instead of having to familiarize themselves with different accessibility requirements constantly anew. While it is probably apparent that neither authors nor publishers may bear the costs of accessibility alone, perhaps the capabilities of generative artificial intelligence and vision language models hold particular promise to

streamline and maybe even accelerate the publishing process for all parties involved in both a compliant and enabling fashion.

Assistive Technology Providers & AI Developers are still at the forefront to help VIIs to independently participate in scientific discourse. Nevertheless, development of instruments aimed at assisting authors likewise enhances availability of accessible materials at the source. Here, tools like Pa11y provide an open-source compliance check for standards like WCAG -in particular, by checking whether alt-texts for scientific imagery is appropriate for VIIs. Still, also assuring that transformed images have sufficient context linkage to their corresponding textual work provides promising potential for VLM technology and generative AI in general. Crucially with regards to pending adjudication, it needs to be determined whether an algorithmic, encoded representation of a protected work constitutes classical copyright infringement, and whether such circumvention by the Marrakesh VIP treaty still conflicts with author distribution rights under the purview of the Berne Three-Step Test. Should the principles of the print-media domain likewise be mirrored in the digital and AI domain, this might enable an AI company to hypothetically transform any number of desired works and even be able to exchange any AFCs —perhaps even in training data form— across borders, proving the company fulfills the requirements of an authorized entity pursuant to Marrakesh Treaty. Still, the question needs to be asked whether such a business model would be sustainable if the underlying VLM or even just the training data cannot be further leveraged and made available to non-beneficiary, sighted users.

Lastly, VIIs are provided with a widening array of legal instruments and often even financial assistance for enabling access to scientific imagery. As demonstrated, mechanisms of the Marrakesh treaty and tangential national laws are traditionally print and copyright oriented. Digital aspects such as *sui generis* rights afforded to non-creative databases and personally identifiable data localization requirements present possible liability challenges to the VII, –in particular, when scientific publication contents are exchanged or processed across borders. Legal defenses must be established to speedily prevent preemptive blocking of assistive tools and prevent VIIs (or other entities acting on their behalf) from being mistaken to illegitimately text-and-data-mine protected works.

Despite tightening governmental and institutional budgets, it remains essential for this beneficiary group that both regulatory and financial support in accessing assistive tech is preserved, just as much as societal understanding has to match the momentum of technological innovation such that the valued place of visually impaired individuals and their unique perspective in scientific discourse is assured.

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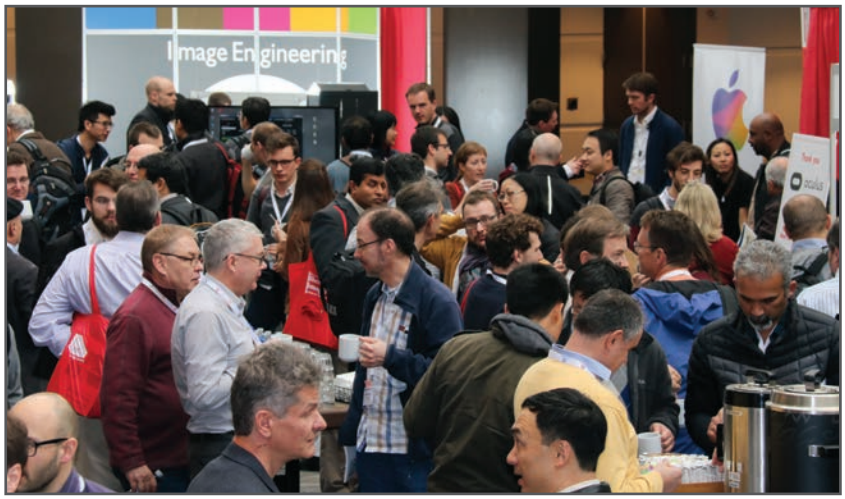

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