

Cristina Formenti

The environmental footprint of animated realism: An ecomaterialist exploration of contemporary digital animated documentaries

2024

<https://doi.org/10.25969/mediarep/22811>

Veröffentlichungsversion / published version
Zeitschriftenartikel / journal article

Empfohlene Zitierung / Suggested Citation:

Formenti, Cristina: The environmental footprint of animated realism: An ecomaterialist exploration of contemporary digital animated documentaries. In: *NECSUS_European Journal of Media Studies*. #Open, Jg. 13 (2024), Nr. 1, S. 221–241. DOI: <https://doi.org/10.25969/mediarep/22811>.

Nutzungsbedingungen:

Dieser Text wird unter einer Creative Commons - Namensnennung - Nicht kommerziell - Keine Bearbeitungen 4.0/ Lizenz zur Verfügung gestellt. Nähere Auskünfte zu dieser Lizenz finden Sie hier:

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Terms of use:

This document is made available under a creative commons - Attribution - Non Commercial - No Derivatives 4.0/ License. For more information see:

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

The environmental footprint of animated realism: An ecomaterialist exploration of contemporary digital animated documentaries

Cristina Formenti

NECSUS 13 (1), Spring 2024: 221-241

URL: <https://necsus-ejms.org/the-environmental-footprint-of-animated-realism-an-ecomaterialist-exploration-of-contemporary-digital-animated-documentaries/>

Abstract

Despite animation techniques being highly material, the environmental impact of animation is understudied. This essay starts bridging the gap by investigating the making of digital animated documentaries through the lens of ecomaterialism. In particular, it brings to light how the quest for realism that prompts the production choices of creators of such works often comes at a significant cost to the environment. Indeed, many present-day digital animated documentaries prove unsustainable, because multi-layered, wasteful, and excess-informed modes of production that foresee a squandering of resources tend to be adopted when making them. In so doing, the need for animation-focused green protocols is made apparent, especially since, paradoxically, due to animation being a craft-oriented medium, such non-environmentally friendly approaches tend to be encouraged within the industry.

Keywords

animation, documentary, environmental sustainability, materialism, production cultures

Since the early 2010s, the relationship between animation and the environment has increasingly been investigated. Yet, existing inquiries mainly look at animation from an ecocritical perspective, examining this medium's role in environmental communication.[1] In other words, they look at the content of animated works, discussing how the latter incorporate ecological themes and portray nature. In fact, to be examined are those works – variably referred to as 'environmental animations' or 'enviro-toons'[2] – that use animation '(and its strengths of abstraction and simplification) to deliberately construct knowledge about the social and ecological processes that affect us and/or the characters and therefore

assist in the creation of environmental subjectivities'.[3] In sum, as Pietari Kääpä would put it, the existing literature primarily scrutinises the ecological 'brainprint'[4] of animation.

Nevertheless, this medium also has an environmental footprint. As Sean Cubitt pointed out, 'animation techniques are highly material in an environmental sense, as well as in terms of labour and toxicology'.[5] For instance, the 2023 issue of the magazine *Green Film Shooting* featured an article that highlighted how, at times, the synthetic materials, paint, and glue employed for stop-motion animation include hazardous constituents that 'are harmful to both human health and the environment' to the point that 'studios must provide their employees with safety instructions, respirators, and gloves'.[6] Similarly, in 2022, the President of Cartoon Italia, Anne-Sophie Vanhollebeke, who is also a producer at the 2D animation company Studio Campedelli, admitted that before digital technologies became so prominent animation was likely the least sustainable sector of the film and media industry, considering that the creation of a traditional hand-drawn animated series of 26 episodes of about 26 minutes each required on average 640,000 sheets of paper (i.e. about 50 tons of paper). In other words, it caused 75 trees to be cut (i.e. the creation of each episode was responsible for cutting almost three trees).[7]

However, digital animation also comes at a significant environmental cost. For example, it was calculated that the footprint of a seven-minute-long episode of the 3D animated series on climate change *Plankton Invasion* (2011) was 417 tons of carbon dioxide. The series had 78 episodes, meaning that, overall, its production ended up being responsible for releasing over 32,500 tons of carbon dioxide into the atmosphere, equivalent to the greenhouse gas emissions from 7,232 gasoline-powered passenger vehicles driven for one year. Consider that this series was made by a particularly eco-conscious company like TeamTo, which not only chose to determine the environmental cost of its production but, among other things, also implemented a double flow-controlled mechanical ventilation system in its studios that allowed for recycling 80% of the heat produced by its computer clusters.[8] Indeed, a particularly non-eco-friendly phase of digital animation proves to be rendering, during which waste heat is generated, in addition to consuming electricity. Hanna Mouchez, the founder and CEO of the Paris-based studio MIAM! Animation, has shown how in a best-case scenario through using the software Maya, a full 11-minute episode in traditional 3D computer-generated animation requires about 230 days to render on a single machine and generates 336 Kg of CO₂. [9] However, usually, each image needs to be rendered at least twice, meaning that the actual environmental footprint of a 3D computer-generated episode is even more significant.

In short, although its impact varies depending on the animation technique adopted, the making of an animated work is far from being carbon neutral. Still, the environmental cost

of animation productions tends to be overlooked even by film commissions and the other organisations engaged in greening the film and media industry. Indeed, while the first green protocols conceived for live-action filmmaking productions made inroads already in the early 2010s, the French association Ecoprod proved to be a pioneer when, in July 2023, it released its *Guide de l'animation éco-responsible* with 60 practical indications that animation studios can follow to reduce their environmental impact. Similarly, in 2022, almost a decade after its introduction, the Italian protocol for greening audiovisual sets known as Ecomuvi started being used in a tailored version for certifying the sustainability of animation productions. This event made headlines as an 'experimental'[10] endeavour. With this prolonged dismissal from the organisations engaged in greening the industry making it even more urgent, this essay bridges the existing gap in scholarship around the environmental sustainability of animation productions by investigating from an ecomaterialist point of view the making of award-winning, digital feature-length animated documentaries, including Ari Folman's *Vals Im Bashir* (*Waltz with Bashir*, 2008), Dorota Kobiela and Hugh Welchman's *Loving Vincent* (2016), and Jonas Poher Rasmussen's *Flugt* (*Flee*, 2021).

Examining these works through the lens of ecomaterialism, which foresees 'moving away from the conventional focus on representation' to instead 'assess the environmental impact of media practices',[11] is crucial because since the late 2000s not only the presence of animated segments within otherwise live-action documentaries has become more common, but also the number of feature-length animated documentaries has progressively grown. Furthermore, like most fact-based animations, these films do not engage with ecological issues content wise. Consequently, they do not even have the excuse that eco-docs and enviro-toons have of at least compensating their environmental footprint with a positive ecological brainprint. Finally, these animated documentaries were produced either independently or anyways outside of the big commercial animation studios. Therefore, underscoring their environmental impact also helps expose how unsustainable practices are not the prerogative of Walt Disney Animation and other world-leading studios. They are rooted within the animation industry more generally. In fact, as I will show to be particularly apparent in the case of *Loving Vincent*, within this sector of the industry, multi-layered and wasteful modes of production that entail an unnecessary consumption of resources are often paradoxically welcomed as an asset.

Undoubtedly, under precise circumstances and if used consciously at this end, the employment of animation to represent the real may allow for shrinking the environmental footprint of a nonfiction production by enabling, for instance, the avoidance (or anyway the reduction) of international travel and preventing the invasion of fragile ecosystems.[12] Yet, as I will demonstrate, the quest for realism that prompts the production and representational choices of digital animated documentaries often leads to the adoption of

modes of production and representation characterised by that superfluity and ‘squandering of resources’ that Nadia Bozak refers to as ‘cinematic excess’.[13] As Nea Ehrlich discussed, in the age of the digital, ‘documentary works still appear to rely heavily on the physically indexical nature of representation to achieve trustworthiness’.[14] Being works that adopt what I call ‘fabled animation’[15] (i.e. animation’s fictional visual language and mode of representation) to illustrate factual occurrences, animated documentaries are better defined as examples of docufictions rather than documentaries, and more precisely as the animated equivalent of docudramas.[16]

Still, their makers feel the need to authenticate their narratives in the eyes of the viewers by showcasing some sort of indexical link with the real. This can be achieved by using sound recordings of real-life interviews or adding some live-action documentary imagery. However, Anastasiia Gushchina has shown how there is also a trend among the makers of animated documentaries to ground the ‘chosen theme in material reality’[17] at the production level through the adoption of physical techniques. I will show that building on this general tendency, even when digital, which ‘is grounded in mathematics and code’ rather than ‘on a material connection to its referent’,[18] is opted for in creating feature-length animated documentaries, unnecessary preliminary physical production steps might be implemented to enhance the animated visuals’ ‘existential link with empirical reality’.[19] In particular, I will illustrate how several award-winning digital animated documentaries share a multi-layered production approach aimed at bringing overt materiality to their animation, whose environmental cost is not justifiable considering that, I contend, it proves only a weakened variant of the authentication practices of seamless integration of the real and the unreal reliant on extratextual knowledge that Vivian Sobchack has theorised.[20]

The creative waste of *Waltz with Bashir*

Based on what one can gain just from watching *Waltz with Bashir*, this animated documentary about the journey undertaken by Folman to recover his lost memories of fighting in the 1982 Lebanon War would seem to be a mostly-CGI feature film – obtained combining a digital cut-out animation technique with some 3D animation – that ends with live action archival footage. Even if this were the case, the film would have already come at a significant environmental cost. As anticipated, digital animation is not immaterial nor carbon neutral.[21] Yet, *Waltz with Bashir* is in fact a doubled live action/animation production. Although Folman always intended for his film to be an animated documentary,[22] before even getting to the animation stage the 90-page screenplay he wrote was shot in live action in a sound studio. As Bozak highlights, ‘however intangible or immaterial they might heretofore appear to be’, cinematic images – be they analog or digital – ‘come bearing a physical and biophysical makeup, and leave behind a residue’.[23] Therefore, like any

cinematic image, the ones resulting from this physical re-enactment of Folman's script can be viewed as materials in themselves.

This footage, however, does not feature in any way in the finished film. Indeed, Folman himself was keen to highlight that the animation technique known as rotoscoping, which would have allowed him to include those cinematic images in the film, since it entails creating motion by tracing live action footage frame by frame, was not employed for *Waltz with Bashir*. In other words, he explicitly rejected a technique that facilitates 'an indexical transference of reality and materiality from an original body into its filmic copy, and then again into its animated incarnation'.^[24] On the contrary, the 3,500 drawings that illustrator David Polonsky and his team made, which were then digitally disassembled into hundreds of basic parts and animated using Flash software, were created from scratch. The live action material was edited together only to be used as a reference for creating the storyboard and, subsequently, the animatic. It was the latter that 'served as the primary source for animators to inform them how people moved', rather than the live action footage, as the crew stresses in the making-of documentary *Surreal Soldiers: Making Waltz with Bashir*.^[25] When filming the live action 'version' Folman had already established, based on the previously completed project *The Material that Love Is Made of* (2004), that rotoscoping was unsuitable for conveying the emotions that he needed to communicate.^[26] Therefore, he shot these live action cinematic materials already knowing that he would have separated them from the final product at an early stage of the production. Yet, as Bozak discusses with regards to the shots cut out during the editing stage, any (audiovisual) image created but then separated from the final work (i.e. not included in its final version) ends up becoming "'creative' waste".^[27] From an ecomaterialist standpoint, we can thus conclude that the film's live action 'version' was made to swiftly be turned into creative waste, since it was born to be discarded well before reaching the final stage of production.

A question naturally arises: why then invest resources and time in filming these live action materials? Folman and his crew justified this step as needed to ensure that the animation ended up bestowing 'a feeling of authenticity'.^[28] However, on closer inspection, it added materiality to the overall production pipeline more than actual realism. Albeit the events it narrated were factual, in filming it Folman did not opt for real location shooting, nor did he try to recreate the original settings in the studio. On the contrary, this live action staging of the script was somewhat impressionistic. A description of how they operated that the director offered makes it evident:

We tried to dramatize those scenes in the studio as much as we could ... We'd sit in two chairs with a plastic grill in front and pretend we were in a car.^[29]

In addition, the cast did not comprise just social actors. For instance, a professional screen performer, Yehezkel Lazarov, interprets Folman's friend Carmi Can'n.

In fact, if as Lúcia Nagib argues 'modes of production' are 'the *objective* way of proofing and proving a film's intention',[30] a look at the decisions taken in creating this animated documentary suggests that visual authenticity was not an actual priority. The inherent indexicality of the live action images that were initially shot was not carried over into the animation, refuting the technique that would have enabled it: rotoscoping. Consequently, as scholars Anniek Plomp and Charles Forceville highlighted, for how realistic in design it might seem, the film's 'animation ... has no direct visual indexical bind to reality'.[31] What is more, upon creating the animated visuals, Polonsky and his team chose not to opt for a photorealist graphic style but rather one variably described as 'simplified naturalism',[32] 'not abstract but ... formally non-naturalistic',[33] and 'simultaneously realistic and fantastical'.[34] As scholar Annabelle Honess Roe pointed out, although the characters 'look realistic', 'the animation design ... is still highly stylized, an effect gained in part through light-and-shadow techniques',[35] and in part via an expressionist use of colour. In fact, while wanting to create drawings rich in details and portray people and not caricatures, Polonsky never intended for his artwork to be an exact graphic reproduction of its real-life referents. Not having a first-hand experience of the events that he was drawing, nor having personally met the people who lived them or having seen with his own eyes the landscapes of Lebanon where the events in the story were set, Polonsky aimed at evoking a feeling of the original occurrences, people, and places by tapping into personal experiences. For instance, since he could not go to Lebanon he drew the landscapes from Northern Israel, which he knew well and were similar to the ones in Lebanon, only not disrupted by war. He explained:

Take the coastal road in Lebanon, for example. I thought about it a lot and finally realized that it was just an extension of the coastal road between Haifa and Tel Aviv, a road I've been on thousands of times in my life. I thought of my childhood, of a special light I like, of the mountains and of the hills, and literally drew from my own experience.[36]

In short, to put it as Nagib would, the production choices made in creating this animated feature do not point in the direction of an actual quest for the 'realism as mode of production'[37] that would have justified the making of the film's preliminary live action cinematic materials.

Considering the foregoing and that Polonsky and his team could have obtained non-caricatural figures even without such footage being created, shooting it proves rather a way of exploiting the means of production to establish a somewhat physical link between the film's realist-but-not-photorealist digital animation and the real. Indeed, as media theorist Lev Manovich discusses, computer-generated images can exhibit at best a 'synthetic realism', because with digital animation 'reality itself has to be constructed from scratch before it can

be photographed by a virtual camera';[38] in other words, it is always a simulated reality. For this reason, according to Manovich's theorisation, the resulting synthetic images would always point to a 'future event'[39] rather than to a past one, as live action images instead do. In this perspective, the shooting of the film's preliminary live action version can be viewed as an attempt to ensure that the film's synthetic images are read as past ones and thus as a stab at authenticating as factual the events in them narrated in the eyes of the viewers.

More precisely, since one must come across the film's paratexts to be aware of a preliminary live action version of the film, the authentication is attempted through extratextual knowledge of the production of this animated documentary. In her essay 'The charge of the real', Sobchack illustrates how extracinematic and extratextual knowledge exert pressures 'on the viewer's experience and valuation of a given cinematic object'.[40] Consequently, it can be used to suggest that 'documentary and verisimilar fictional space are constituted from the same worldly "stuff" – the former giving existential ballast to the "realism" of the latter even as its specificity is usually bracketed and put out of play and on the sidelines of our consciousness'.[41] For instance, Sobchack has shown how the extratextual knowledge of the real death of a rabbit in Jean Renoir's *La règle du jeu* (*Rules of the Game*, 1939) or of Woody Allen and Mia Farrow going through a scandalous breakup like the characters that they interpret in *Husbands and Wives* (1992) brings viewers to read momentarily the fictional space of these films as documentary space. Likewise, the live action step in the making of *Waltz with Bashir* can be viewed as a way of creating extratextual knowledge potentially capable of grounding in explicit, albeit indirect, materiality the digital animation images that make up the film and thus of charging their 'unreal' nature (i.e. their being non-indexical) with a phantasmatic 'real' (i.e. a phantasmatic indexicality).

However, *Waltz with Bashir* contains documentary live action cinematic materials that bear an actual indexical link to the events recounted and thus more readily and directly authenticate the whole film (including its animation) as factual, content wise. Indeed, an audiovisual work does not have to be entirely in animation to qualify as an animated documentary. Although there is a debate among scholars on what the maximum amount contained should be before having to classify it otherwise, there is agreement that an animated documentary can also contain live action footage.[42] And in *Waltz with Bashir*, Folman not only included the latter, but he did so in an eco-sustainable way since he used archival footage – and therefore he recycled existing cinematic materials rather than creating new ones. Accordingly, the making of the preliminary live action version was non-essential and from an ecomaterialist perspective proves to be an example of 'cinematic excess' at the production stage, 'a gratuity, an opulence of choice and an indulgence in materials, as well as in space, time and energy'.[43] In fact, if we proceed from Bozak's

agreeable principle that to be able to consider cinematic images as ecologically made they should be created with less,[44] extending what Hunter Vaughan discusses in relationship to *Avatar*, we can consider per se a ‘doubled production – once according to traditional methods of analogue material production and again according to the energy-driven digital methods –’[45] a form of cinematic excess and thus an unsustainable practice.

From one film’s unsustainable approach to a production practice

Having garnered worldwide critical acclaim and prestigious honours – including an Oscar nomination for Best International Feature and a Golden Globe for Best Foreign Language Film – *Waltz with Bashir* went on to become a reference point for filmmakers wishing to depict real-life occurrences through animation.[46] This, however, meant that its superfluous and wasteful grounding of the animated visuals in greater materiality was also (and still is) replicated, more or less closely, by other directors and became a recursive production practice.

More precisely, there are three main ways in which this furthering of animation’s materiality has been attempted, with consequent variations in terms of environmental impact. The first consists in employing motion capture (MoCap). A case in point is Raul De La Fuente and Damian Nenow’s *Jeszcze dzień życia* (*Another Day of Life*, 2018), about the journey undertaken by Polish foreign correspondent Ryszard Kapuściński across a war-torn Angola in 1975. The materiality of this feature’s 3D digital animation was deepened by utilising the MoCap technique to capture the performances of professional, physical actors who, not dissimilar from what happened with *Waltz with Bashir*, re-enacted factual occurrences in a studio equipped with basic props. While still adding to the environmental cost of the film’s making, at least this approach has the merit of preventing creative waste from being generated. Indeed, in this case, what is enacted in front of the camera is translated not into video footage but into spatial coordinates that are then used to shape the performances of the animated actors. Ehrlich has, however, pointed out that the index generated is a ‘weakened’ one because although the spatial coordinates obtained act ‘as a trace’ for creating the animated visuals, the latter do not necessarily have to end up being ‘iconic (resembling the referent)’.[47] They can also be ‘symbolic (arbitrarily designed)’, since the ‘semantic distance between cause and effect, i.e., physical movement and animated representation’[48] is not impeded. Therefore, the animation is charged only with a phantasmatic real, albeit with a less illusory one than in the case of *Waltz with Bashir*.

A second way in which the materiality of digital animated documentaries’ animated visuals is boosted entails shooting and editing a preliminary live action version of the film to use as a reference, exactly as was done for *Waltz with Bashir*. This footage, however, is not

necessarily the result of staging in a sound studio. Let us consider for instance *Flugt*, Rasmussen's animated documentary about the real life, traumatic story of the Afghan refugee known by the pseudonym of Amin Nawabi. Despite already intending to employ digital animation to protect the identity of his subject, Rasmussen almost slavishly imitated what Folman had done for his animated documentary and started the production of *Flugt* by shooting and editing a preliminary live action version of the film. Yet instead of re-enacting everything in a studio, he shot it as a 'conventional' live action documentary. That is, he filmed his interviews with Amin, and did standard live action documentary coverage, capturing his subject in various daily situations, such as driving a car or talking in the kitchen with his partner.[49] Nonetheless, like Folman's, this footage was not included in the film nor was it shot to be rotoscoped. It was created only to act as a reference for the animators, who then crafted the visuals from scratch. In ecomaterialist terms, it was thus produced to become creative waste. In addition, in this case, a lavish attitude, characterised by an overproduction exploitative of the access possibilities allowed by digital animation, was also adopted in generating the animated visuals. Indeed, lead animator Kenneth Ledkjær relayed:

We were sitting right next door to the edit suite and Janus would run in and say, 'Can I get a close-up of Amin, looking a bit angry from left to right? And then a wide shot from above?' and we'd sketch that, really quickly. ... We'd provide him with a lot of 'footage,' so to speak, that he could play with, like you would with a documentary.[50]

In sum, *Flugt* ended up being responsible for an environmental footprint that was at least double what a 'conventional' live action documentary on the same subject would have had, for no other reason than the fact that, as discussed, they shot a conventional documentary in the early stages of production.

There is also a third and even less sustainable way of manufacturing the visuals of digital feature-length animated documentaries that, next to generating cinematic and non-cinematic creative waste, also requires a wealth of 'raw' materials. It consists of creating digital animation visuals from live action footage with the sole purpose of utilising this cinematic material as a reference for crafting the actual artwork for the animation with a physical technique, and then digitising the resulting images. This was the approach adopted in making most of the animated visuals of Stefano Savona's *La strada dei Samouni* (2018). Taking as a basis live action footage shot by Savona in Gaza, the digital animators first created 3D models of the Samouni district and the social actors and, subsequently, 3D hyper-realist animated sequences. As far as this film's animated component was concerned, the production could have thus ended here. Yet only a small part of these cinematic materials was incorporated into the film – e.g. the shots from the points-of-view of drones and helicopters. The rest was swiftly turned into creative waste in that it was treated just as reference material for lead animator Simone Massi and his team of artists to look at when physically redrawing each shot anew by hand. More precisely, they re-crafted every image

by spreading black pastels on paper and scratching out the colour where needed with pointy tools to obtain imperfect aesthetics that recall those of engravings (see Fig. 1). As such, 18,348 physical drawings were made for 38 minutes of animation, which meant that at least as many sheets of paper as well as a significant number of pastels were employed. However, these resources were used to implement a superfluous production step since Massi's engraving aesthetics could have been re-created digitally.



Fig. 1. A shot from Massi's animation in *La strada dei Samouni*.

Like in the case of *Waltz with Bashir*, for *Jeszcze dzień życia*, *Flugt*, and *La strada dei Samouni* matters of animated realism were adduced to justify the addition of the above-mentioned physical steps in creating the animated visuals. More precisely, Nenow declared with regards to the animation of *Jeszcze dzień życia*: 'The acting skills of artists like Mirek Haniszewski, Olga Boładź, or Tomek Ziętek introduces additional value to the picture – even a couple dozen of our best animators wouldn't be able to deliver animation as rich and comprehensive as it is when augmented by live actors.' [51] Similarly, in talking about *Flee*, Ladekjær explained:

We wanted animation that could carry the realism of the story, and at the same time feel like a movie for adults ... We leaned towards live-action cinema in the way it simulates realism, and our cinematography followed the rules of reality. [52]

Referring to the physical work done by Massi for *La strada dei Samouni*, Savona instead stated: 'I think that the tremendous quantity of time and manual gestures incorporated in each drawing also gives a documentary dimension to what he is creating.' [53]

Yet, for all three films, a realist-but-not-photorealist visual style was mainly opted for, and in *Jeszcze dzień życia* and *Flugt* the latter even gives way at times respectively to 'interludes of overt surrealism' [54] and almost abstract sequences (see Figure 2).



Fig. 2: A shot from one of the *Flugt* animated scenes leaning towards abstraction.

What is more, in the case of *Flugt* the preliminary live action ‘version’ of the film was looked at to copy aspects of Amin’s style and behaviours, but not his physical appearance, which the animators instead *had* to detach from. Indeed, to put it as Ehrlich would, in *Flugt* animation was employed as a form of ‘masking’.[55] Thereby, Amin’s actual appearance could not be replicated, meaning that alterations had to be made with respect to the reference materials filmed, a fact that renders the shooting and editing of the latter an even more unnecessary gesture.

Like the initial dramatisation of Folman’s script in a studio, the use of MoCap in *Jeszcze dzień życia*, the doubled live action/animation approach in *Flugt*, and the digital-physical-digital one in *La strada dei Samouni* also are examples of cinematic excess at the production stage. Indeed, once again, to know that these strategies were employed, and thus to read the resulting animation as a documentary space, one must have come across paratexts of these animated documentaries wherein their making is discussed. Besides, as in *Waltz with Bashir*, *Jeszcze dzień życia*, *Flugt*, and *La strada di Samouni* also contain actual live action documentary footage, which is a much more potent and straightforward ‘warranting device’[56] for asserting the factual nature of what they narrate.

In fact, in these animated documentaries, the presence of live action documentary material is even more tangible than it was in *Waltz with Bashir*. Indeed, in all three movies, it is more sizable in terms of overall running time.[57] In addition, while exactly like in Folman’s film, the live action documentary footage present in *Flugt* is, for the most part, sustainable in that it amounts to archival material, the one in *Jeszcze dzień życia* and *La strada dei Samouni* came at a higher environmental cost because it was expressly shot for these movies (more or less) abundantly relying on international travel. More precisely, the live action footage included in Savona’s film resulted from two trips to Gaza between 2009 and 2010. The one present in

Jeszcze dzień życia was instead the outcome of two journeys to Angola – one in 2011 and one in 2015 – as well as of voyages to Barcelona, Lisbon, La Havana, and Warszawa to interview people connected to Kapuscinski's story. So, all three animated documentaries already contained cinematic materials capable of charging the film with the real, but also in two out of the three cases, the shooting of this footage had a significant environmental impact due to the transportation emissions produced. From an environmental perspective, the chosen multi-layered and wasteful practices for creating animated visuals thus prove even more unsustainable in their superfluity.

Loving Vincent but not the planet

Among the animated documentaries with the least sustainable production is *Loving Vincent*, an account of the late painter Vincent Van Gogh based on letters he wrote. Perhaps to compensate for being entirely in animation, this feature was made by combining the digital-physical-digital approach of *La strada dei Samouni* with an even more carbon-heavy variant of the doubled live action/animation method used for *Waltz with Bashir* and *Flugt*. More precisely, *Loving Vincent* was first shot at Three Mills Studios in London and CETA studio in Wrocław as a live action film with physical, professional actors dressed in costumes to resemble figures portrayed in the oils of the famed Dutch artist. After two weeks of shooting in London the crew moved to Poland to film body doubles for another two weeks. Also, while about 80 percent of the scenes were shot against a green screen, 20 percent were filmed against sets specially built to resemble Van Gogh paintings.

To make this preliminary live action version, carbon dioxide connected both to international travel and to areas normally part of the environmental impact of fiction filmmaking (such as costuming, makeup, and set construction) was thus dispersed in the atmosphere. Furthermore, the live action materials obtained were then composited with matte paintings created digitally, mainly using Photoshop. Subsequently, 2D and 3D digital animation elements (e.g. blowing leaves or a steam train) were even added to some of these shots to imbue the backgrounds with movement and depth. From an ecomaterialist perspective, this therefore meant appending a rendering-related carbon footprint to the already mentioned environmental impact. Once again, all the foregoing was undertaken to then turn most of the resulting cinematic materials into creative waste at the production stage. Indeed, while a small portion of the digital images obtained (e.g. those concerning flashbacks) was rotoscoped, and thus was not fully separated from the final film, all the others were, since they were treated just as references; more precisely, they were painted anew in Van Gogh's style on a physical support – i.e. canvas – by artists and then recorded with a Canon D20 digital still camera at 6k resolution and digitally retouched. Concretely, this meant 65,000 frames were painted on canvases sized 67 cm x 49 cm, requiring over 1,000 canvases as well

as 6,500 tubes and 1,300 litres of Royal Talens paint.[58] Therefore, sizable 'raw' materials were also exploited to create physical images that then had to be digitalised.

Everything detailed above is just a portion of the environmental costs of *Loving Vincent*. Further physical and digital creative waste was fabricated during pre-production. Indeed, even before shooting the film's preliminary live action version, 377 oil paintings were physically created by design painters and then digitised – yet none of them appear in the finished film. They were just circulated among the artists 'creating the final oil paintings to use as reference'.[59] Also, additional, substantial travel-related emissions were produced; part of them resulted from trips that the directors took for research purposes.[60] However, the most consistent portion was connected to the painters employed.

The mode of production chosen for creating *Loving Vincent* required hiring 125 artists who, as is stressed in the film's press kit with some pride, 'travelled from all across the world to the *Loving Vincent* studios in Poland and Greece to be a part of the production'.[61] For instance, several US painters were hired. Among them was 26-year-old Natalie Gregoraz from Lincoln Park, who explained that prior to being recruited she was flown to Poland for 'a three-day working audition'.[62] Indeed, 5,000 artists applied to work on this animated feature, and to choose the 125 who became part of the crew hundreds were interviewed via in-person auditions in Poland.[63] In addition, during the production phase, the selected painters were made to travel across Europe. Indeed, 97 painting animation workstations composed of a table, a monitor, a DSLR camera, and a projector were installed at studios in the two Polish cities of Gdansk and Wroclaw, and in Athens in Greece. Yet the painters were not assigned for the entire duration of their employment to just one of these studios. They had to move between them.[64]

In brief, even if its carbon footprint was not measured, between travel-related emissions, raw materials used, and creative and non-creative waste produced, the making of this animated documentary proves to be far from environmentally friendly and certainly less eco-sustainable than a 'regular' live action documentary or digital animation film would have been. Again, this multi-layered pipeline was undertaken in the name of realism. More precisely, it was apparently the desire to avoid caricatural characters combined with an attempt to achieve realism at the mode of production by way of emulating Van Gogh's approach to portraiture that led to this articulated pipeline. The two directors of the film explained the choice of departing from a live action shoot with actors as such:

Vincent worked from real people when he did his portraits, and wanted to convey the emotion of the real person in front of them. Likewise, we wanted to have real people in front of us, and feel their emotion.[65]

However, realism at the mode of production seems to not have been a chief pursuit of the directors, if 31 of Van Gogh's paintings included in the film were altered in some way (changing the colours, frame, style, or season and time of day of the artist's original artwork) to follow the story. Furthermore, once again, all the above-mentioned physical steps were undertaken to craft non-indexical, realist but non-photorealist animated visuals, since the visual style adopted was Van Gogh's Post-Impressionism. Undeniably, unlike the other titles analysed in this essay, *Loving Vincent* partially foregrounded its materiality in its opening credits by mentioning the step of hand-painting on canvas. However, to fully grasp the scale of the operation undertaken to ground this film's animated visuals in overt physicality, viewers still need to acquire extratextual knowledge. Also, the indexicality of the animated visuals remains phantasmatic, and the overall pipeline of the film an evident case of cinematic excess at the stage of production.

The consequences of rewarding unsustainability

Wasteful and resource-intensive production choices implemented in the name of realism are not a prerogative of animated documentaries nor animation more generally. For example, when Greta Gerwig's live action blockbuster *Barbie* (2023) was to be released, the statement from production designer Sarah Greenwood that during the creation of the film's sets so much paint was employed that 'the world ran out of pink'[66] was harnessed to build hype around the movie. This was an overstatement, because the construction of Barbie Land caused a run just on Rosco paint's fluorescent pink.[67] If the *Barbie* production emptied this company's supply of that shade it was because Rosco that year already had less stock available due to a deep freeze that occurred in Texas in early 2021, which damaged vital resources used to create that paint. Yet, when the various media outlets delivered the news worldwide, they hardly mentioned that climate change was behind the shortage, nor did they portray the excessive use of paint made by the *Barbie* crew as a shortcoming of the movie in terms of the production's environmental footprint. On the contrary, they mostly presented it as proof that, in line with what Gerwig declared, efforts were put into ensuring that the childlike nature of the Barbie world was maintained in creating the film's sets. In other words, media outlets acted as a megaphone for the narrative of the marketing office, which presented an environmentally-harmful action such as exhausting a resource as an asset of the movie in terms of achieving the 'authentic artificiality'[68] that its director was aiming for.

The cases of the animated documentaries analysed here prove, however, that when it comes to animation this phenomenon is not confined to big Hollywood productions. Even relatively low-budget and small, independent productions might hide multi-layered, labour-and-resource-intensive but superfluous approaches. Indeed, if we were to conceptualise the

animation production as a continuum characterised by the poles of 'sustainability' and 'unsustainability', the digital animation documentaries scrutinised here would position themselves towards the latter's extreme. Albeit with some differences, they are all made adopting modes of production that foreground (creative) waste and a superfluous overproduction of images. To paraphrase Vaughan, we could thus say that dissecting these digital animation documentaries from an ecomaterialist perspective makes apparent how 'the hidden environmental impact' of how films are made, watched, and disposed of is not just 'Hollywood's dirtiest secret'.^[69]

The biggest issue, however, is that since animation is a craft-oriented medium, the cinematic excess at the production stage of animated works tends to be applauded by the industry (and not only) as a strength, rewarding it with prestigious awards and nominations rather than stigmatising it for its environmental implications. It becomes flagrant if we look at the reception of *Loving Vincent*. Film critics praised this feature's craft and technique and devoted ample space in their reviews to detail with admiration the many steps of its production pipeline without ever stopping to consider their environmental costs.^[70] Most significantly, this animated documentary went on to collect high-status nominations, including one for Best Animated Feature at the 90th Academy Awards, and prizes, including a European Film Award for Best Animated Feature Film – exclusively in virtue of its unsustainable craft. Many defects were recognised in the film on other levels. For instance, its story was judged weak and not fully developed, and its pace and musical score 'uneven'.^[71] Yet its elaborate, unsustainable pipeline made the industry turn a blind eye to these shortcomings.

From an environmental point of view, such an attitude is counterproductive because it further contributes to establishing the consideration of wasteful and excessive modes of production as acceptable and even desirable. On the contrary, in a time like the present, in which climate change is accelerating and its consequences are increasingly tangible, it is urgent to eradicate such unsustainable approaches via the introduction of green protocols capable of stimulating makers to find production solutions for reducing creative waste and the squandering of resources. At the same time, when awarding a film, nominating it for a prize, or making it the object of critical acclaim, we should start considering the environmental implications of its making because, as the case of digital animated documentaries proves, the risk of encouraging the development of further unsustainable production cultures is always behind the corner.

Author

Cristina Formenti is Assistant Professor in Film Studies at the University of Udine, where she is undertaking the research project *For an environmentally sustainable documentary*. She is the author of *Il mockumentary: la fiction si maschera da documentario* (Mimesis 2013) and *The classical animated documentary and its contemporary evolution* (Bloomsbury 2022). Her work has been published in various national and international journals, including *Studies in Documentary Film*, *Alphaville*, and *Horror Studies*. She serves as President of the Society for Animation Studies and is on the Governing Council of Visible Evidence. She is co-editor of the journal *Animation Studies* and of the book series *Animation: Key films/filmmakers* (Bloomsbury).

Acknowledgements

This research was supported by the European Social Fund REACT EU – Programma Operativo Nazionale Ricerca e Innovazione 2014-2020.

References

- AnimatonXpress Team. 'MIAM! animation's animated series *Edmond and Lucy* is a good mix of entertainment and eco-responsibility', *Animation Xpress.com*, 24 June 2022: <https://www.animationxpress.com/animation/miam-animations-animated-series-edmond-and-lucy-is-a-good-mix-of-entertainment-and-eco-responsibility/> (accessed on 5 January 2024).
- Anonymous. 'This animated life: An interview with David Polonsky', *Words Without Borders*, 2009, available at: <https://wordswithoutborders.org/read/article/2009-02/this-animated-life-an-interview-with-david-polonsky/> (accessed on 5 January 2024).
- Bouldin, J. 'Cadaver of the real: animation, rotoscoping and the politics of the body', *Animation Journal*, Vol. 12, 2004: 7-31.
- Bozak, N. *The cinematic footprint: Lights, camera, natural resources*. New Jersey: Rutgers University Press, 2012.
- Brink, J. L. 'Animating trauma: *Waltz with Bashir*, David Polonsky' in *Killer images: Documentary film, memory and the performance of violence*, edited by J. ten Brink and J. Oppenheimer. New York: Columbia University Press, 2012: 127-135.
- Burr, T. 'Loving Vincent gets style points for Van Gogh visuals', *The Boston Globe*, 6 October 2017: G7.
- Caraway, K. and Caraway, B.R. 'Representing ecological crises in children's media: An analysis of *The Lorax* and *Wall-E*', *Environmental Communication*, Vol. 14, No. 5, 2020: 686-697.
- Casetti, F. 'Sutured reality: Film, from photographic to digital', *October*, Vol. 138, Fall 2011: 95-106.
- Cubitt, S. 'Ecocritique and the materialities of animation' in *Pervasive animation*, edited by S. Buchan. New York-Abingdon: Routledge, 2013: 94-114.

THE ENVIRONMENTAL FOOTPRINT OF ANIMATED REALISM: AN ECOMATERIALIST EXPLORATION OF CONTEMPORARY DIGITAL ANIMATED DOCUMENTARIES

- _____. *Anecdotal evidence: Ecocritique from Hollywood to the mass image*. New York: Oxford University Press, 2020.
- Ehrlich, N. 'Animated documentary as masking', *Animation Studies*, Vol. 6, 2011: <https://journal.animationstudies.org/nea-ehrllich-animated-documentaries-as-masking/> (accessed on 5 January 2024).
- _____. 'The animated document. Animation's dual indexicality in mixed realities', *animation: an interdisciplinary journal*, Vol. 15, No. 3: 260-275.
- Formenti, C. *The classical animated documentary and its contemporary evolution*. New York-London: Bloomsbury, 2022.
- _____. 'Beyond greenwashed protocols: The reconversion of existing modes of representation as a new possible approach to the cutback of the documentary film's environmental footprint', *Comunicazioni Sociali. Journal of Media, Performing Arts and Cultural Studies*, Vol. 49, No. 2, 2022: 180-193.
- Gushchina, A. 'Towards a materialist theory of animated documentary', *Animation Studies*, Vol. 18, 2023: <https://journal.animationstudies.org/category/volume-18/anastasiya-gushchina-towards-a-materialist-theory-of-animated-documentary-winner/> (accessed on 5 January 2024).
- Heidsiek, B. 'Let's green it in post', *Green Film Shooting*, No. 5, 2017: 20-21.
- _____. 'Stop using chemicals. Launching minimum ecological standards for stop-motion animation films', *Green Film Shooting*, No. 11, 2023: 24-25.
- Heise, U.K. 'Plasmatic nature: Environmentalism and animated film', *Public Culture*, Vol. 26, No. 2, 2014: 301-318.
- Hinds, J. 'Local artist helps *Loving Vincent* bring Van Gogh to life', *Detroit Free Press*, 12 October 2017: D10.
- Honess Roe, A. *Animated documentary*. London: Palgrave McMillan, 2013.
- Kääpä, P. *Environmental management of the media: Policy, industry, practice*. Abingdon-New York: Routledge, 2018.
- Kaufman, D. 'How they did it: *Waltz with Bashir*', *studiodaily*, 18 December 2008: <https://www.studiodaily.com/2008/12/how-they-did-it-waltz-with-bashir/> (accessed on 14 January 2024).
- Kenigsberg, B. '*Another Day of Life* review: A memoir of war, in full color', *The New York Times*, 12 September 2019: <https://www.nytimes.com/2019/09/12/movies/another-day-of-life-review.html> (accessed on 10 January 2024).
- Macdonald, M. '*Loving Vincent* is an exquisite movie about Van Gogh', *Sant Louis Post-Dispatch*, 27 October 2017: G20.
- MacDonnell, B. 'Loving Vincent', *The Oklahoman*, 3 November 2017: D4.
- Malle, C. 'Inside the Barbie Dreamhouse, a fuchsia fantasy inspired by Palm Springs', *Architectural Digest*, 30 May 2023: <https://www.architecturaldigest.com/story/inside-the-barbie-dreamhouse-a-fuchsia-fantasy-inspired-by-palm-springs> (accessed on 25 January 2024).
- Manovich, L. *The language of new media*. Cambridge: The MIT Press, 2001.
- Midkiff, E. and Austin, S. 'The disneyfication of climate crisis: Negotiating responsibility and climate action in *Frozen*, *Moana*, and *Frozen 2*', *The Lion and the Unicorn*, Vol. 45, No. 2, 2021: 154-171.
- Mo.Sa. 'L'animazione si fa sostenibile. In Sardegna la prima sperimentazione di un protocollo green dedicato all'animazione', *Italy for Movies*, 13 October 2022: <https://www.italyformovies.it/news/detail/1320/lanimazione-si-fa-sostenibile-in-sardegna-la-prima-sperimentazione-di-un-protocollo-green-dedicato-allanimazione> (accessed on 12 January 2024).

- Moore, E. 'Green screen or smokescreen? Hollywood's messages about nature and the environment', *Environmental communication*, Vol. 10, No. 5, 2015: 539-555.
- Murray, R. and Heumann, J.K. *That's all folks? Ecocritical readings of American animated features*. Lincoln: University of Nebraska Press, 2011.
- Nagib, L. *Realist cinema as world cinema: Non-cinema, intermedial passages, total cinema*. Amsterdam: Amsterdam University Press, 2020.
- Parham, J. *Green media and popular culture: An introduction*. London: Palgrave MacMillan, 2016.
- Pfeiffer, O. 'Animating Gallipoli: Leanne Pooley and Matthew Metcalfe on 25 April', *Metro Magazine. Media and Education Magazine*, No. 188, 2016: 90-93.
- Pike, D.M. *Enviro-toons: Green themes in animation cinema and television*. Jefferson: McFarland, 2012.
- Plomp, A. and Forceville, C. 'Evaluating animatory's potential as a rhetorical genre', *Visual Communication*, Vol. 20, No. 3, 2021: 353-373.
- Ristola, J. 'Recreating reality: *Waltz with Bashir*, *Persepolis*, and the documentary genre', *Animation Studies*, Vol. 11, 2016: <https://journal.animationstudies.org/jacqueline-ristola-recreating-reality-waltz-with-bashir-persepolis-documentary/> (accessed on 12 January 2024).
- Robertson, B. 'Painterly impression', *Computer Graphics World*, September-October 2017: 6-8.
- Roxborough, S. 'The making of *Flee*', *Hollywood Reporter*, Vol. 427, No. 42, 8 December 2021: 22-25.
- Smith, M.J. and Parsons, E. 'Animating child activism: Environmentalism and class politics in Ghibli's *Princess Mononoke* (1997) and Fox's *Fern Gully* (1992)', *Continuum*, Vol. 26, No. 1, 2012: 25-37.
- Sobchack, V. *Carnal thoughts: Embodiment and moving image culture*. Berkeley: University of California Press, 2004.
- Starosielski, N. "'Movements that are drawn": A history of environmental animation from *The Lorax* to *Fern Gully* to *Avatar*', *The International Communication Gazette*, Vol. 73, No. 1-2, 2011: 145-163.
- Thomas, R. '*Loving Vincent* is an astonishing celebration of Van Gogh', *The Capital Times*, 15 November 2017: 032.
- Valdez, J. '*Barbie* production emptied a company's worldwide supply of pink paint', *Los Angeles Times*, 3 June 2023: <https://www.latimes.com/entertainment-arts/movies/story/2023-06-03/barbie-production-design-shortage-pink-paint-greta-gerwig> (accessed on 25 January 2024).
- Vaughan, H. 'Screen theory beyond the human: Toward an ecomaterialism of the moving image' in *The anthem book of screen theory*, edited by H. Vaughan and T. Conley. London-New York: Anthem Press, 2018: 195-224.
- _____. *Hollywood's dirtiest secret: The hidden environmental costs of the movies*. New York: Columbia University Press, 2019.
- Ward, P. 'Drama-documentary, ethics and notions of performance: The *Flight 93* films' in *Rethinking documentary*, edited by T. Austin and W. De Jong. Maidenhead: Open University Press, 2008: 191-203.
- Wiktor, M. 'Interview with Daniel Nenow, co-director of *Another Day of Life* – Poland's submission to 2020 Oscars', *Austin Polish Film Festival*, 21 October 2019: <https://www.austinpolfilm.com/apff-blog/2019/10/21/interview-with-damian-nenow-co-director-of-another-day-of-life-polands-submission-to-2020-oscats> (accessed on 5 January 2024).

Notes

- [1] See among others Murray & Heumann 2011; Starosielski 2011; Smith & Parsons 2012; Pike 2012; Heise 2014; Moore 2015; Parham 2016, pp. 230-258; Cubitt 2020, pp. 51-69, 201-219; Caraway & Caraway 2020; Midkiff & Austin 2021.
- [2] See respectively Straosielski 2011; Pike 2012.
- [3] Straosielski 2011, p. 146.
- [4] Kääpä 2018, p. 9.
- [5] Cubitt 2013, p. 95.
- [6] Heidsiek 2023, p. 25.
- [7] Mo.Sa. 2022.
- [8] See Heidsiek 2017, p. 21.
- [9] See AnimationXpress Team 2022.
- [10] E.g., see Mo.Sa. 2022.
- [11] Vaughan 2018, p. 198.
- [12] See Formenti 2022, pp. 189-192.
- [13] Bozak 2012, p. 126.
- [14] Ehrlich 2020, p. 266.
- [15] Formenti 2022, pp. 28-32.
- [16] For a detailed discussion of the animated documentary's classification see Formenti 2022, pp. 34-48.
- [17] Gushchina 2023.
- [18] Ehrlich 2020, p. 269.
- [19] Casetti 2011, p. 96.
- [20] See Sobchack 2004, pp. 258-285.
- [21] For an in-depth discussion of CGI's materiality and potential footprint see Vaughan 2019, pp. 137-163.
- [22] See Pressbook of *Waltz with Bashir*, World Cinema Publicity, 2008, <https://www.the-match-factory.com/catalogue/films/waltz-with-bashir.html?file=files/downloads-public/films/w/waltz-with-bashir/waltz-with-bashir-pressbook.pdf> (accessed 5 January 2024).
- [23] Bozak 2012, p. 8.
- [24] Bouldin 2004, p. 13.
- [25] Ristola 2016.
- [26] Kaufman 2008.
- [27] Bozak 2012, p. 159.
- [28] Polonsky in Brink 2012, p. 127.
- [29] Kaufman 2008.
- [30] Nagib 2020, p. 30.
- [31] Plomp & Forceville 2021, p. 359.
- [32] Ristola 2016.

- [33] Ehrlich 2011.
- [34] Honess Roe 2013, p. 162.
- [35] Ibid.
- [36] Polonsky in Anonymous 2009.
- [37] Nagib 2020, p. 19ff.
- [38] Manovich 2001, p. 192.
- [39] Ibid., p. 203.
- [40] Sobchack 2004, p. 272.
- [41] Ibid., p. 275.
- [42] See Honess Roe 2013, p. 4; Formenti 2022, pp. 1-2.
- [43] Bozak 2012, p. 122.
- [44] Ibid., p. 170.
- [45] Vaughan 2019, p. 157.
- [46] Various filmmakers made explicit the fact of having looked up to *Waltz with Bashir* in creating their animated documentaries (see Pfeiffer 2016, p. 90; Wiktor 2019).
- [47] Ehrlich 2020, p. 267.
- [48] Ibid.
- [49] See Roxborough 2021, p. 23.
- [50] Ladekjær in Ibid., p. 25.
- [51] Pressbook of *Another Day of Life*, Platige Image, 2016, <https://www.platige.com/wp-content/uploads/2016/05/Another-Day-of-Life-Pressbook.pdf>, p. 32 (accessed on 5 January 2024)
- [52] Ladekjær in *Flee Press Notes*, Neon, 2021, <https://neon.app.box.com/s/xg3qnelfunnjri3ei1ypy7pmo9d8wrcf/file/855298450860> (accessed on 5 January 2024).
- [53] Savona in *Press kit of Samouni Road, Rendez Vous*, 2018, https://www.picofilms.com/_files/ugd/9ec529_7c8742c4a64b4d4fbf093fa7a59a7e27.pdf?index=true (accessed on 5 January 2024).
- [54] Kenigsberg 2019.
- [55] Ehrlich 2011.
- [56] Ward 2008, p. 198.
- [57] For instance, the live action footage in *Jeszcze dzień życia* amounts to approximately 20 minutes, while in *Waltz with Bashir* to about two minutes.
- [58] For a detailed account of this film's making see the press kit for *Loving Vincent*, <https://lovingvincent.com/images/glowne/Loving%20Vincent%20%20Press%20Kit%20US.pdf>, pp. 29, 31-33; Robertson 2017.
- [59] Robertson 2017, p. 8.
- [60] Press kit, *Loving Vincent*, p. 24.
- [61] Ibid., p. 3.
- [62] Hinds 2017, p. D10.
- [63] See Robertson 2017, p. 8.
- [64] Hinds 2017, p. D10.

THE ENVIRONMENTAL FOOTPRINT OF ANIMATED REALISM: AN ECOMATERIALIST EXPLORATION OF CONTEMPORARY DIGITAL ANIMATED DOCUMENTARIES

[65] Press kit, *Loving Vincent*, p. 24.

[66] Malle 2023.

[67] See Valdez 2023.

[68] Gerwig in Malle 2023.

[69] Vaughan 2019, pp. 1-2.

[70] See Burr 2017; Macdonald 2017; MacDonnell 2017; Thomas 2017.

[71] See, respectively, Macdonald 2017, p. G20; MacDonnell 2017, p. D4.