

Transforming Scarcity: Posthuman Subjectivity and Ecological Vulnerability in Frank Herbert's *Dune* and Denis Villeneuve's Film Adaptation

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Abstract

Frank Herbert's Dune (1965) and Denis Villeneuve's cinematic adaptation, comprising Dune (2021) and Dune: Part Two (2024), construct Arrakis as an ecological system in which human existence is inseparable from environmental conditions. While much of the critical discussion surrounding Dune has focused on ecology, imperialism, resource extraction, religion, and environmental politics, this article examines the relationship between ecological transformation, posthuman subjectivity, and vulnerability. Drawing on Rosi Braidotti's conception of the posthuman subject, N. Katherine Hayles's critique of autonomous humanism, Stacy Alaimo's concept of trans-corporeality, and Cary Wolfe's critique of human exceptionalism, the article argues that Dune destabilises the autonomous human subject by presenting identity as relational, embodied, environmentally embedded, and vulnerable. Water scarcity, stillsuits, spice, sandworms, Fremen ecological knowledge, and Paul Atreides's transformation collectively demonstrate that the human subject cannot exist independently of material and nonhuman systems. The films extend this argument through visual, auditory, and corporeal representations of the desert, making ecological vulnerability perceptible through cinematic form. Villeneuve's adaptation particularly emphasises the physical scale of Arrakis, the vulnerability of the human body, the transformative effects of spice, and the ambiguous relationship between Paul and the Fremen world. The article contends that vulnerability in

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Dune should not be understood merely as weakness but as a constitutive condition of posthuman existence. By transforming scarcity into ecological knowledge and interdependence, Herbert and Villeneuve challenge human exceptionalism and propose a form of subjectivity in which survival depends on recognising the interconnectedness of human, technological, ecological, and nonhuman systems.

Keywords: Dune, Frank Herbert, Denis Villeneuve, posthumanism, posthuman subjectivity, vulnerability, ecological vulnerability, ecocriticism, trans-corporeality, science fiction cinema.

Introduction

Science fiction has historically provided a significant imaginative space for questioning the boundaries of the human. Through encounters with artificial intelligence, extraterrestrial life, genetic transformation, technological augmentation, environmental catastrophe, and altered consciousness, science fiction repeatedly destabilises the assumption that the human subject is autonomous, rational, stable, and separate from the nonhuman world. Contemporary posthuman theory similarly challenges the humanist conception of the individual as an independent subject positioned above other forms of life. Rosi Braidotti argues that the critical posthuman subject is “a relational subject constituted in and by multiplicity” and stresses its embodied and embedded character (Braidotti 49–50). Her formulation is particularly useful for interpreting speculative narratives in which the boundaries separating humans from environments, technologies, animals, and other material forces become unstable.

Frank Herbert’s *Dune* provides an especially productive site for such an investigation. Published in 1965, the novel constructs Arrakis as a desert planet whose ecological conditions determine the possibilities of human survival. Water scarcity, sandstorms, sandworms, spice production, bodily adaptation, and Fremen culture are not separate components of the narrative. They form an interconnected ecological system. Human beings on Arrakis cannot simply position themselves outside the environment and attempt to dominate it. Their survival requires continuous adaptation to ecological conditions (Herbert 29–30).

Denis Villeneuve’s adaptation intensifies this ecological dimension through cinema. *Dune* (2021) and *Dune: Part Two* (2024) translate Herbert’s ecological imagination into vast landscapes, embodied performances, soundscapes, visual contrasts, and representations of human vulnerability against the scale of Arrakis. The films do not merely reproduce the novel but reinterpret its concerns through the possibilities of cinematic form. The desert becomes simultaneously an environment, a political space, a sensory experience, and a force that shapes human identity.

Much of the existing scholarship on *Dune* has examined the novel through ecological and environmental perspectives. Miłkołaj Smykowski reads Herbert’s *Dune* as an “ecoprophetic” work and connects its waterless ecosystem to Anthropocene concerns (Smykowski 233–35). Veronika Kratz historicises Herbert’s ecological thought by examining his engagement with sand-dune stabilisation and environmental science (Kratz 637–42). Such scholarship establishes the significance

of ecology in Herbert's work. Other approaches have examined resource extraction, imperialism, religion, Indigenous representation, and environmental politics. Mécheri's ecocritical study is particularly relevant to the comparison between Herbert's novel and Villeneuve's adaptation, foregrounding the environmental dimensions shared by the two versions (Mécheri 745-50).

The present article builds upon these approaches but shifts the emphasis from ecology as a thematic concern to ecology as a condition of subject formation. Rather than asking only how *Dune* represents environmental crisis, the article asks, 'What happens to the human subject when survival depends upon continuous interaction with an unstable ecological system? ' How does water scarcity transform the relationship between body and environment? How does spice alter consciousness? How does Fremen ecological knowledge challenge the idea of technological mastery? How does the sandworm destabilise human claims to dominance? And how does Villeneuve's cinematic representation make these forms of vulnerability visible?

These questions are particularly relevant to the concept of posthuman subjectivity. Braidotti describes the posthuman subject as relational, embodied, embedded, and connected to human and nonhuman agents (49-50). Her approach moves away from the autonomous individual toward a subject constituted through relationships. Similarly, Stacy Alaimo's concept of trans-corporeality describes the "movement across bodies and nature" and foregrounds the material interconnections between human bodies and the more-than-human world (2-3). In *Dune*, the body is constantly involved in such exchanges. Water leaves the body and must be reclaimed; spice enters the body and transforms consciousness; the desert determines bodily practices; and the human community is shaped by the biological systems of Arrakis.

The article therefore proposes that *Dune* represents the human subject as fundamentally vulnerable because it is essentially relational. Vulnerability is not simply a condition imposed upon a stable subject from outside. It emerges from the subject's dependence upon ecological and material systems. The human is vulnerable. It is embodied. It needs water. It breathes an atmosphere because it depends upon other organisms and because its consciousness can be transformed by substances originating outside itself.

The central argument of this article is that Herbert's *Dune* and Villeneuve's film adaptation transform ecological scarcity into a framework for rethinking subjectivity. Arrakis does not merely threaten human beings; it produces particular forms of human knowledge, identity, culture, and embodiment. The Fremen represent a form of ecological subjectivity developed through long-term adaptation to the desert. Paul Atreides, meanwhile, undergoes a transformation in which ecological exposure, spice consumption, Fremen knowledge, and altered perception increasingly destabilise his prior identity. The cinematic adaptation makes this transformation especially visible by placing the human body within overwhelming environmental spaces.

The article argues that this transformation can be understood through four connected concepts: posthuman subjectivity, ecological vulnerability, trans-corporeality, and nonhuman agency. Braidotti's later formulation of the critical posthumanities further situates posthuman inquiry within post-anthropocentric and materially embedded relations (Braidotti, "A Theoretical Framework" 31-33). These concepts reveal that *Dune* is not merely concerned with whether humanity can survive a hostile planet. It asks what humanity becomes when survival requires recognition of its dependence upon the nonhuman.

2. Literature Review

2.1 Posthuman Subjectivity

Posthumanism provides the principal theoretical framework for this study. The posthuman turn challenges the traditional humanist image of the autonomous individual as the universal measure of value and knowledge. Rosi Braidotti argues that posthuman subjectivity emerges from a critique of anthropocentrism and human exceptionalism (49-50). Rather than imagining the subject as an isolated consciousness, posthuman theory understands subjectivity as relational, embodied, affective, and embedded within material environments (Braidotti 49-50).

Braidotti's formulation is particularly relevant to *Dune* because Arrakis repeatedly demonstrates the impossibility of human autonomy (Braidotti 49-50). The inhabitants of the planet depend upon ecological systems that precede and exceed individual human intention. Water determines survival; spice alters consciousness; sandworms shape the economy; and the desert determines patterns of movement and habitation.

Braidotti's posthuman framework therefore allows the analysis to move beyond the simple claim that *Dune* is an ecological novel. The more important question is how ecology becomes constitutive of subjectivity. The environment does not simply surround the human subject. It participates in producing the conditions under which the subject exists.

2.2 Embodiment, Technology, and the Posthuman

N. Katherine Hayles's *How We Became Posthuman* provides another significant theoretical foundation. Hayles critiques the tendency to separate information from embodiment and argues that embodiment has been systematically marginalised in cybernetic constructions of the posthuman (4-5). Her work is particularly useful for analysing the stillsuit, spice, and Paul's altered consciousness. The stillsuit provides an example of technological embodiment. It does not simply protect the body from the desert. It becomes part of the body's survival system by reclaiming moisture that would otherwise be lost. Technology therefore does not function as an external instrument used by an autonomous human. It becomes incorporated into the processes through which the human body remains viable.

Similarly, spice complicates the distinction between biological substance and consciousness. Its effects extend beyond the body into perception, memory, political

power, and temporal awareness. Paul's transformation demonstrates that consciousness itself can become environmentally mediated.

2.3 Trans-Corporeality and Ecological Materialism

Stacy Alaimo's concept of trans-corporeality further develops this understanding. In *Bodily Natures*, Alaimo describes the material movement between human bodies and environments as a "movement across bodies and nature" (2-3). The body is therefore porous rather than sealed.

This concept is especially productive in *Dune*. Water, spice, sand, heat, and atmospheric conditions all interact with the human body. The Fremen have developed technologies and practices that acknowledge this permeability rather than denying it. The desert therefore becomes part of human embodiment. The Fremen do not merely inhabit Arrakis; they have shaped their bodies and cultural practices through it.

2.4 Ecological Readings of *Dune*

Ecocritical scholarship has long recognised Arrakis as one of the most important environmental settings in twentieth-century science fiction. Smykowski identifies *Dune* as an ecoprophetic text whose waterless ecosystem reflects ecological anxieties and possible futures of environmental crisis (233-35). Kratz, meanwhile, connects Herbert's ecological thinking with the history of sand-dune stabilisation and applied environmental science (637-42).

Such scholarship demonstrates that the ecological dimension of *Dune* is historically and theoretically significant. However, the present study extends this discussion by asking how ecological conditions transform the human subject itself.

2.5 Vulnerability and Posthumanism

Vulnerability is central to this argument because posthuman subjectivity cannot be understood solely through transformation and agency. Relational existence also produces exposure. The autonomous humanist subject attempts to imagine itself as self-sufficient. The posthuman subject recognises that its existence depends on other bodies, species, technologies, environments, and material systems (Braidotti 49-50; Wolfe xv).

In *Dune*, vulnerability is therefore ecological. The human subject is vulnerable to thirst, heat, storms, worms, political systems, and environmental transformation. Yet this vulnerability also generates knowledge. The Fremen survive precisely because they understand their vulnerability to the desert. Consequently, *Dune* suggests a paradox: "The recognition of vulnerability becomes a condition of survival" (Braidotti 40, 49-50). This paradox forms the central theoretical contribution of the article.

3. Aim and Objectives

Aim

The primary aim of this article is to examine how Frank Herbert's *Dune* and

Denis Villeneuve's film adaptation construct posthuman subjectivity through ecological interdependence and vulnerability.

Objectives

The article seeks:

1. To examine how *Dune* destabilises the autonomous human subject through ecological interdependence.
2. To analyse the relationship between ecological scarcity, vulnerability, and the formation of posthuman subjectivity.
3. To examine water scarcity, stillsuits, and spice as representations of embodied and trans-corporeal experience.
4. To analyse Fremen ecological knowledge, sandworms, and Paul Atreides's transformation through a posthumanist lens.
5. To compare Herbert's novel and Villeneuve's films in their representation of ecological vulnerability, nonhuman agency, and human-environment relationships.

4. Methodology

This study adopts a qualitative interdisciplinary methodology based primarily on close textual and cinematic analysis. The principal texts are Frank Herbert's *Dune* (1965) and Denis Villeneuve's *Dune* (2021) and *Dune: Part Two* (2024).

The analysis draws on posthuman theory, ecocriticism, the environmental humanities, and theories of embodied subjectivity. Rosi Braidotti's concept of relational posthuman subjectivity provides the primary theoretical framework (49–50). N. Katherine Hayles is used to examine embodiment, technology, and the relationship between consciousness and materiality (2–5). Stacy Alaimo's concept of trans-corporeality is used to analyse the movement between bodies and environments (2–3). Cary Wolfe's critique of human exceptionalism contributes to the analysis of nonhuman agency (xv, 45–49).

The study uses close reading to examine selected episodes involving water, stillsuits, spice, sandworms, Fremen culture, Paul Atreides, Liet-Kynes, and ecological transformation. The cinematic analysis focuses on visual composition, landscape, sound, scale, bodily performance, editing, and the representation of environmental vulnerability.

The comparison between the novel and film does not treat the adaptation as a simple reproduction of Herbert's narrative. Instead, the films are considered interpretive transformations. The novel can represent internal consciousness through narration, description, dialogue, and access to multiple perspectives, while cinema can externalise ecological relations through image, sound, movement, scale, and embodied performance. The methodology therefore treats adaptation as a form of theoretical reinterpretation. The objective is to identify how the transition from literary narrative to cinematic representation changes how posthuman subjectivity

and vulnerability become perceptible.

The study does not claim that Herbert or Villeneuve consciously intended to illustrate contemporary posthuman theory. Instead, posthuman theory is used as a critical framework through which the ecological and embodied dimensions of the texts can be reconsidered.

5. Analysis

5.1 Arrakis and the Crisis of Human Autonomy

The first challenge to autonomous subjectivity in *Dune* emerges from the ecological structure of Arrakis. The novel itself immediately places Arrakis at the centre of Paul's story, describing it as the planet "known as Dune" and repeatedly tying the character's future to the desert world (Herbert 3). The planet does not function as passive scenery. It establishes the fundamental conditions within which human beings can exist. Water is scarce, the desert is expansive, sandstorms are dangerous, and the sandworm dominates the landscape. These conditions shape human settlements, movement, clothing, technology, and cultural practices.

This ecological structure challenges the humanist assumption that humans can create their own conditions of existence independently of the environment.

On Arrakis, the human body is visibly dependent.

- ❖ It needs water.
- ❖ It needs protection from heat.
- ❖ It needs technological assistance.
- ❖ It needs collective knowledge.
- ❖ It needs an understanding of nonhuman life.

The human subject is therefore not autonomous but ecologically embedded.

Braidotti's posthuman framework is useful here because the subject is understood as relational rather than self-contained (49-50). Arrakis makes this relationality unavoidable. A person cannot simply decide to ignore the desert. The environment continually shapes the construction of daily life.

Villeneuve's films make this condition particularly visible through scale. Human figures are repeatedly placed against enormous deserts, massive sandworms, vast spaces, and violent environmental forces. The visual relationship between the small human body and the immense landscape challenges the viewer's expectation that the human figure occupies the centre of the frame. The desert becomes a visual decentring of the human figure. In conventional heroic cinema, landscape often functions as a background against which the protagonist acts. In *Dune*, the landscape frequently appears to possess a scale and force that exceed the protagonist.

The human is not the measure of Arrakis. Arrakis becomes the measure within which humans must survive. This shift from human-centred space to ecological space is one of the first manifestations of posthuman subjectivity in the narrative.

5.2 Water Scarcity and Ecological Vulnerability

Water is perhaps the clearest material representation of vulnerability in *Dune*. The novel makes this vulnerability explicit when Paul learns that the Fremen wear stillsuits that “reclaim the body’s own water” (Herbert 29).

On Arrakis, water is not simply scarce. Its scarcity reshapes social life. The Fremen collect and conserve moisture, use stillsuits, and treat bodily water as a valuable communal substance. Death itself becomes part of a water economy because the moisture contained within the body can return to the community. Kynes explains the principle succinctly: “A man’s flesh is his own; the water belongs to the tribe” (Herbert 304). The significance of these practices extends beyond environmental adaptation.

They challenge the modern conception of the body as a private and autonomous entity. The Fremen body is not understood as an isolated possession. Its water belongs to a wider social and ecological system. This understanding is deeply compatible with trans-corporeal theory. Alaimo’s conception of bodily permeability emphasises that bodies are constantly engaged in material exchanges with their environments (2–3). The Fremen culture makes this principle explicit. The body loses water. The environment threatens the body. Technology recovers water. The community receives water. The individual therefore exists within a continuous circulation of matter. The stillsuit intensifies this argument.

The suit is a technological system designed around the biological vulnerability of the body. Kynes explains that a functioning Fremen suit can reduce moisture loss to “a thimbleful a day” (Herbert 29). It collects perspiration, urine, and other bodily moisture and makes it available for reuse. The technology does not eliminate vulnerability. Instead, it acknowledges vulnerability and develops a means of living within it. This distinction is crucial.

A conventional technological model might imagine technology as a means of defeating nature. The stillsuit represents something different. It is a technology of ecological accommodation. It allows humans to remain vulnerable while developing methods of survival within that vulnerability. This approach makes the stillsuit an important posthuman object. The human body and technological apparatus form an integrated survival system. Human survival is therefore not simply biological. It is biological + technological + ecological + social.

Villeneuve’s films make this relationship corporeal. The physicality of the stillsuits, the desert heat, the movement of characters across sand, and the emphasis on bodily exhaustion repeatedly remind the viewer that survival is an embodied process. Scarcity thus becomes transformative. It does not merely restrict human action. It produces new technologies, customs, identities, and forms of knowledge.

5.3 The Fremen and Ecological Subjectivity

The Fremen represent perhaps the clearest alternative to the imperial model of

human-environment relations. The imperial powers approach Arrakis primarily through extraction. They centre their interest on spice, economic value, political control, and technological management. The Fremen understand Arrakis through lived experience. Their knowledge is embodied and communal. They know the desert through movement, observation, memory, ritual, and adaptation. Their ecological knowledge is therefore not simply information about the environment. It is a way of being within the environment. This distinction is important for posthuman subjectivity. The Fremen do not imagine themselves as completely separate from the desert. Their identity is shaped by the conditions of Arrakis. Their language, clothing, rituals, social structures, and survival practices emerge from ecological necessity. The desert becomes part of their cultural subjectivity

In this respect, Fremen identity illustrates Braidotti's relational conception of the subject, in which the self is constituted through multiple relations and belongings (49–50). Identity is not produced in isolation but through relationships with material and nonhuman forces. Villeneuve's cinematic representation reinforces this relationship. The films repeatedly associate the Fremen with movement through the desert, the rhythmic patterns of sand, communal rituals, and the presence of sandworms. The Fremen do not simply occupy the desert. They have learnt to read the desert well. This capacity to read ecological conditions becomes a form of power. The Empire possesses political and technological power, but the Fremen possess ecological knowledge.

This distinction is crucial because it challenges the assumption that technological sophistication automatically produces greater mastery over nature. The imperial system is powerful but ecologically dependent. The Fremen appear politically marginalised, yet they possess knowledge that is essential for their survival. The narrative therefore reverses conventional hierarchies of knowledge.

5.4 Spice and the Transformation of Consciousness

Spice represents another crucial challenge to the autonomous human subject. Its material effects connect bodily experience, perception, political economy, and ecological systems (Herbert 89–90). Melange is not simply an economic resource. It alters perception and consciousness. Its importance extends across biological, political, economic, and cognitive domains. For Paul Atreides, spice exposure becomes central to his transformation. Before Arrakis, Paul is already positioned within political structures that define his identity as the heir of House Atreides. His identity appears relatively stable. Arrakis destabilises that identity. His encounters with the desert, the Fremen, spice, and prescient visions gradually transform his understanding of himself.

Spice, therefore, operates as a material agent in the transformation of subjectivity. The substance enters the body, but it produces effects that exceed the body. It changes perception. It alters temporal awareness. It transforms political possibility. It complicates personal identity.

This relationship between matter and consciousness challenges the assumption that subjectivity is purely internal. Paul's consciousness is partly produced through material interaction.

This is where Hayles's emphasis on embodiment becomes particularly relevant. Hayles's account of posthumanism insists on the importance of the material conditions through which consciousness and subjectivity are constructed (2-5). Consciousness cannot be completely separated from the material conditions through which it emerges. Paul's transformation can therefore be understood as a movement toward posthuman becoming. He does not simply acquire more knowledge. His mode of perceiving reality changes.

His relationship with time changes. His relationship with the environment changes. His relationship with the Fremen changes. His political identity changes. The subject is transformed through its encounter with the nonhuman.

5.5 Paul Atreides and the Vulnerable Posthuman Subject

Paul's transformation is often interpreted through the conventional framework of the hero's journey. He enters a hostile environment, gains knowledge, acquires power, and eventually becomes a leader. A posthuman reading complicates this trajectory. Paul does not simply become more powerful. He also becomes more vulnerable to the consequences of his altered perception. His prescience does not provide complete freedom.

Instead, it creates an increasingly complex awareness of possible futures. Knowledge becomes a source of vulnerability. Paul's transformation is also framed by the Bene Gesserit discipline of fear: "I must not fear. Fear is the mind-killer" (Herbert 8). This paradox is central to the posthuman subject. The more Paul understands the interconnectedness of events, the less easily he can imagine himself as an autonomous agent. His decisions are embedded within historical, political, ecological, religious, and cultural systems. He becomes powerful precisely as his autonomy becomes uncertain.

Villeneuve emphasises this tension through both performance and cinematic framing. Paul's transformation is represented not only through dialogue but also through changes in his bodily presence, relationships, expressions, and interactions with the Fremen world. The cinematic Paul increasingly belongs to two worlds. He is Atreides and Fremen. He is an outsider and a participant. He is a political heir and desert warrior. He is an individual and a symbolic figure. His identity becomes relational. This character is one of the strongest examples of posthuman subjectivity in the narrative. The subject does not simply acquire another identity. The boundaries of identity become unstable.

5.6 Sandworms and Nonhuman Agency

The sandworm represents one of the most significant challenges to human exceptionalism in *Dune*. From an imperial perspective, the worm is a threat to spice harvesting. From an ecological perspective, however, the worm is integral to the

planetary system. The sandworm, therefore, cannot be understood merely as an antagonist. It is an ecological agent. The imperial economy depends upon the very organism that makes spice production possible. This creates a paradox:

The Empire seeks to control the resource while remaining dependent upon the nonhuman system that produces it. The sandworm thus exposes the limits of human mastery. No political authority can simply command the worm. No technology eliminates the ecological risks associated with it. The creature determines movement, mining practices, and human settlement. Its agency is not human-like intention. Rather, it is ecological agency: the capacity of a nonhuman organism and its life system to shape the conditions of human action. Cary Wolfe's critique of human exceptionalism is useful here. He argues against the "fantasies of disembodiment and autonomy" inherited from humanism (xv). Posthumanism does not require treating animals as identical to humans. Instead, it challenges the hierarchy that places human interests at its unquestioned centre. The sandworm occupies a different form of existence, yet its existence determines human possibilities.

Villeneuve's films intensify this idea through cinematic scale. The worm's appearance is accompanied by enormous physical movement, sound, vibration, and spatial disruption. The human body becomes visually and acoustically insignificant in comparison. The viewer experiences the worm not merely as a creature but as an environmental event. The film is a significant cinematic achievement. The novel describes the ecological system through language and narrative explanation. The film makes the viewer experience scale. The result is a more embodied representation of human vulnerability.

5.7 Liet-Kynes and Ecological Systems Thinking

Liet-Kynes provides another important figure for understanding posthuman ecological subjectivity (Herbert 426–29). Kynes does not view Arrakis merely as an empty desert waiting to be exploited. The planet is understood as a system. Water, vegetation, sandworms, climate, and human communities are interconnected. The ecological vision of transforming Arrakis therefore differs from imperial extraction. The Empire asks how spice can be produced. Kynes asks how the planet can sustain different forms of life.

This distinction demonstrates two different approaches to ecological knowledge. The first treats nature as a resource. The second treats nature as a system. The second approach is closer to posthuman ecological thought, as it recognises that human interests cannot be separated from wider planetary processes. Yet Herbert also complicates this ecological transformation. Changing Arrakis is not necessarily an uncomplicated good. If the ecological system changes radically, the sandworm population and spice production may also change. This produces an important ethical question:

Who has the authority to decide what a planet should become?

The question is directly relevant to contemporary debates surrounding climate engineering and planetary intervention. The posthuman perspective does not simply

reject intervention. Instead, it asks humans to recognise that intervention occurs within systems they cannot fully control. Kynes's ecological vision therefore represents both hope and uncertainty.

5.8 From Scarcity to Sustainability

The concept of transforming scarcity into sustainability is central to the article. Herbert's ecological vision links water scarcity, Fremen adaptation, and long-term planetary transformation (Herbert 476). Scarcity initially appears as a condition of deprivation. Arrakis lacks accessible water. However, scarcity also produces knowledge. The Fremen develop methods of conservation. They create stillsuits. They organise communities around water. They develop ecological knowledge. They understand the relationships between sandworms, water, spice, and climate. Scarcity, therefore, becomes productive. It produces a different form of subjectivity. The Fremen subject is not defined by unlimited consumption. It is defined by ecological awareness. This does not mean that scarcity itself is desirable.

Rather, Herbert demonstrates that human responses to scarcity can take different forms. The imperial response is extraction and control. The Fremen response is adaptation and collective ecological knowledge. The difference is significant for sustainability. Sustainability is often understood as the efficient management of resources.

Dune offers a stronger possibility. Sustainability requires a transformation in how humans understand their relationship with ecological systems. It requires recognition of limits. It requires collective responsibility. It requires adaptation. It requires acceptance of vulnerability. The posthuman subject is therefore potentially a sustainable subject, as it recognises that human survival depends on nonhuman systems.

5.9 Cinematic Vulnerability in Villeneuve's Adaptation

The transition from novel to film changes how ecological vulnerability is communicated.

Herbert can describe the internal states of characters, explain ecological systems, and provide conceptual information through narrative.

Villeneuve must translate these elements into visual and auditory experience. The films therefore emphasise (Villeneuve, *Dune*; Villeneuve, *Dune: Part Two*):

- ❖ immense landscapes
- ❖ bodily movement
- ❖ environmental scale
- ❖ sound
- ❖ heat
- ❖ darkness
- ❖ sand
- ❖ water

- ❖ bodily exhaustion
- ❖ technological clothing
- ❖ encounters with sandworms

The result is an embodied ecological experience. One of the most significant features of Villeneuve's adaptation is the repeated visual reduction of the human body within the landscape.

Characters appear small against the desert. Vehicles appear vulnerable against storms and sandworms. Buildings seem temporary. The landscape appears continuous. This visual relationship challenges the assumption that humans should occupy the centre of cinematic attention. The desert frequently becomes the dominant visual presence. The effect is not simply aesthetic. It is philosophical. The viewer is encouraged to perceive the human as one element within a larger system. Sound also contributes to this effect. The roar and movement associated with sandworms, the atmosphere of storms, and Hans Zimmer's musical score create an auditory environment in which the desert appears to possess overwhelming material force.

Cinema therefore turns ecological vulnerability into sensory experience. The viewer does not merely understand that the characters are vulnerable. The viewer experiences their smallness.

5.10 Water, the Body, and the Ethics of Survival

The representation of water in Villeneuve's films also carries ethical significance. Water is repeatedly associated with the human body, death, survival, and cultural identity. The Fremen's relationship with water challenges the modern viewer's assumption that water is an ordinary commodity. The films make water appear precious precisely because its absence dominates the landscape. This produces an inversion of everyday perception. What is normally invisible becomes culturally significant. The absence of water becomes a presence. The human body itself becomes a site of ecological accounting. Every drop matters. Every loss matters. Every bodily fluid becomes potentially valuable. This transforms the meaning of embodiment. The body is no longer simply the site of individual identity. It becomes part of an ecological circulation.

This is precisely where Alaimo's concept of trans-corporeality becomes useful: the body is understood through its material exchanges with the environment (2-3). Bodies are not sealed units. They exchange matter with environments. *Dune* makes that exchange dramatically visible.

6. Findings / Results

The comparative analysis of Herbert's novel and Villeneuve's films produces several significant findings.

6.1 Human Subjectivity Is Ecologically Constructed

The first finding is that *Dune* destabilises the concept of an autonomous human subject. Human identity is shaped by environmental conditions, social relations, technological systems, and nonhuman organisms (Braidotti 49-50; Alaimo 2-3). Arrakis does not simply provide a setting for human experience. It participates in

the formation of that experience.

6.2 Vulnerability Is Constitutive Rather Than Accidental

The second finding is that vulnerability is not presented merely as a weakness of particular characters. All human beings on Arrakis are vulnerable because they depend upon ecological systems. This makes vulnerability a condition of existence rather than an exceptional state.

6.3 Scarcity Produces Ecological Knowledge

The third finding is that scarcity can produce sophisticated forms of environmental knowledge. The Fremen's practices demonstrate that ecological vulnerability can generate adaptation, technological innovation, collective responsibility, and cultural transformation.

6.4 Technology Does Not Eliminate Vulnerability

The fourth finding concerns the stillsuit and other technologies (Herbert 29). Technology allows humans to survive the desert, but it does not free them from ecological dependence. Instead, technology becomes integrated with the body. The posthuman subject is therefore partly technological but remains environmentally dependent.

6.5 Spice Destabilises the Boundary Between Environment and Consciousness

The fifth finding is that spice demonstrates the material basis of altered consciousness (Herbert 89–90). Paul's transformation suggests that environmental substances can materially influence subjectivity. The boundary between the external environment and internal consciousness consequently becomes unstable.

6.6 Nonhuman Agency Challenges Human Exceptionalism:

The sixth finding is that sandworms and ecological systems possess forms of agency that constrain human political and economic power (Wolfe 45–49). The Empire's dependence upon Arrakis demonstrates that technological and political power cannot guarantee ecological mastery.

6.7 Villeneuve Makes Vulnerability Visually and Sensorially Perceptible

The seventh finding is that the films translate ecological vulnerability into cinematic form, particularly through landscape, scale, sound, movement, and bodily performance (Villeneuve, *Dune*; Villeneuve, *Dune: Part Two*). Landscape, scale, sound, movement, and bodily performance make the human subject appear physically small and environmentally exposed.

6.8 Posthuman Becoming Involves Both Transformation and Exposure

The final finding is that becoming posthuman does not simply mean acquiring greater power or technological capacity. It also means recognising greater relational dependence. Paul's transformation therefore involves both empowerment and vulnerability.

7. Discussion

The findings demonstrate that *Dune* can be read as a significant posthuman narrative because it shifts attention from the autonomous human individual toward relationships between humans, environments, technologies, animals, substances, and ecological systems. Braidotti's conception of the relational subject provides a

particularly useful framework. The posthuman subject is not defined by separation but by connection. In *Dune*, the individual exists within a network of material dependencies.

Arrakis shaped the Fremen. Paul is transformed by spice and Fremen culture. The Empire depends upon the ecology of spice. The spice economy depends upon sandworms. The sandworms depend upon the ecological conditions of Arrakis. The result is a network rather than a hierarchy. This network challenges anthropocentrism because no single human actor can be understood in isolation from the larger system.

The novel also demonstrates that vulnerability and agency are not opposites. The Fremen are vulnerable to the desert, but their recognition of this vulnerability generates ecological expertise. Paul is vulnerable to transformation, yet this very transformation grants him new forms of perception. The Empire is vulnerable to dependence upon spice, despite possessing extraordinary political power. Thus, vulnerability becomes productive. This aspect is particularly important for posthuman theory because the concept of vulnerability can otherwise be interpreted only in negative terms. A posthuman subject is not powerful because it has escaped vulnerability. It becomes capable of acting because it recognises its embeddedness.

The Fremen's ecological practices exemplify this principle. They do not eliminate the desert. They learn how to inhabit it. This is a crucial distinction. The imperial system seeks to make Arrakis serve its economic objectives. For the Fremen, survival within the ecological limits of Arrakis is paramount. Neither position is completely free from violence or political complexity, but they represent different relationships with ecological vulnerability. The article also demonstrates the significance of the cinematic adaptation.

Villeneuve's films do not simply illustrate Herbert's ecological ideas. They transform them into sensory experiences. The immense scale of the desert reduces the visual dominance of the human body. The sound of the sandworm overwhelms human speech. The movement of sand disrupts human stability. The stillsuit makes the relationship between technology and embodiment visible. Spice sequences transform ordinary perception into an altered visual experience. The adaptation therefore makes posthuman subjectivity experiential. The audience does not merely receive information about ecological interdependence. The audience encounters it through cinematic form. This approach is particularly significant for science fiction cinema.

Cinema can represent posthuman subjectivity not only through dialogue or narrative explanation but also through changes in scale, image, sound, editing, and bodily performance. The human subject can literally become smaller within the frame. The environment can occupy more visual space. Nonhuman movement can become the central event. These cinematic strategies create an aesthetic of decentring.

7.1 Vulnerability Beyond Weakness

One of the central implications of the study is the need to reconsider

vulnerability. In conventional narratives, vulnerability is often associated with weakness. The vulnerable character requires protection. The powerful character overcomes vulnerability. *Dune* complicates this structure. The Fremen are vulnerable because they inhabit a harsh environment. But their vulnerability generates knowledge. Their knowledge produces survival. Their survival produces cultural strength. Vulnerability therefore becomes a source of adaptation. Paul's experience is even more complicated. His increasing knowledge of possible futures does not make him completely free.

Instead, greater knowledge increases his awareness of uncertainty and consequence. The subject becomes more powerful while becoming more deeply entangled within the systems that produce that power. This view is consistent with a posthuman understanding of subjectivity. The subject is neither completely powerless nor completely autonomous. It is relationally capable.

7.2 The Human Body as an Ecological Interface

The analysis of water, stillsuits, and spice also demonstrates that the body functions as an interface between human and nonhuman systems. The Fremen body interacts with the desert through the stillsuit. Spice crosses into the body and alters consciousness. Water moves between the body and the environment. The sandworm's existence determines human movement. The ecological boundary is therefore porous.

This supports Alaimo's trans-corporeal model in which bodies and environments are materially interconnected. The significance of this relationship extends beyond *Dune*. Contemporary ecological crises demonstrate that air pollution, chemicals, viruses, heat, water scarcity, and changing environments expose human bodies. The fantasy of the sealed and autonomous human body becomes increasingly difficult to maintain.

Dune dramatises this condition through its speculative narrative. Arrakis makes material dependence visible.

7.3 The Adaptation and the Transformation of Subjectivity

The comparison between novels and films also demonstrates that adaptation itself can be understood as a process of transformation. Villeneuve's films translate Herbert's ecological and psychological concerns into visual, auditory, and embodied forms (Villeneuve, *Dune*; Villeneuve, *Dune: Part Two*). Herbert's novel provides access to internal consciousness and extensive ecological explanation. Villeneuve's films translate these processes into visual and auditory form. This transformation matters because posthuman subjectivity is not represented identically in different media. The novel can move between thought and environment.

Cinema can place the body directly within the environment. The films, therefore, emphasise corporeal experience. The audience sees characters struggling across sand, riding worms, wearing stillsuits, encountering storms, and confronting enormous ecological spaces. The adaptation makes vulnerability visible. In this sense, Villeneuve's *Dune* does not merely adapt the story. It adapts the novel's ecological philosophy to the sensory possibilities of cinema.

7.4 Beyond Human Exceptionalism

The most significant theoretical implication of the analysis is that *Dune* challenges human exceptionalism without eliminating human agency. This is consistent with Wolfe's distinction between posthumanism and fantasies of transcending embodiment (xv). Humans remain capable of making choices. Paul makes political decisions. The Fremen organise collectively, while Kynes imagines planetary transformation, and Imperial powers manipulate resources. The novel does not deny human agency. Instead, it places agency within ecological constraints.

This is a more nuanced posthuman position than simply declaring that humans are powerless. Human beings possess agency, but that agency is relational. A decision made by a human actor can have ecological consequences. An ecological process can constrain a political decision. A nonhuman organism can also change human behaviour. A material substance can transform consciousness. Subjectivity and environment therefore exist in reciprocal relationships.

8. Conclusion

Frank Herbert's *Dune* and Denis Villeneuve's cinematic adaptation offer a powerful speculative exploration of the relationship between human subjectivity, ecological systems, and vulnerability. Through Arrakis, the narrative destabilises the conventional image of the autonomous human subject and replaces it with a relational model in which human existence is inseparable from environmental, technological, biological, and nonhuman systems. Water scarcity is central to this transformation. On Arrakis, water does not function merely as a resource in short supply. It becomes the foundation of cultural identity, social organisation, technological innovation, and ecological knowledge. The Fremen demonstrate that vulnerability to the environment can generate forms of knowledge that allow human communities to adapt without imagining themselves as completely independent of ecological systems.

The stillsuit provides an especially significant example of posthuman embodiment. It demonstrates that technology does not necessarily liberate the human from nature. Instead, technology becomes integrated with the body, allowing it to remain within an ecological system. The human subject is therefore simultaneously biological, technological, social, and environmental. Spice extends this transformation into the domain of consciousness. Its effects on Paul Atreides destabilise the boundary between his external environment and his internal subjectivity. Paul becomes a posthuman subject not because he simply acquires superior abilities but because his identity becomes increasingly relational. His transformation involves the desert, spice, Fremen culture, political history, inherited memory, and visions of possible futures.

The sandworm similarly challenges human exceptionalism (Herbert 375–76). It represents an ecological agency that cannot be fully controlled by imperial institutions. The Empire depends upon a nonhuman ecological system for the production of its most valuable resource. Political power therefore remains

dependent upon ecological forces. Villeneuve's films intensify these ideas through cinematic form. The scale of Arrakis, the physicality of the desert, the vulnerability of the human body, the sensory force of sandworms, and the visual representation of spice transform ecological concepts into embodied experiences. The films repeatedly reduce the apparent centrality of the human figure and place human bodies within overwhelming ecological spaces.

The article therefore concludes that vulnerability is not an incidental condition in *Dune*. It is constitutive of the posthuman subject. To be vulnerable is to be dependent. To be dependent is to be relational. To be relational is to recognise that human existence is produced through connections with bodies, technologies, environments, substances, animals, and ecological systems. This understanding challenges the humanist desire for complete autonomy. *Dune* does not suggest that human beings must abandon agency. Instead, it proposes a different understanding of agency—one that operates within ecological limits and recognises material interdependence. The transformation from scarcity to sustainability therefore involves more than conserving resources. It requires a transformation of subjectivity itself. The sustainable subject is not the subject who conquers scarcity completely but the subject who understands the ecological relationships through which survival becomes possible.

From this perspective, *Dune* contributes significantly to posthuman science-fiction studies. Its ecological imagination demonstrates that the posthuman is not necessarily a technologically enhanced human or an artificial being. The posthuman can also emerge through ecological entanglement, altered embodiment, nonhuman agency, and the recognition of vulnerability. The significance of Arrakis ultimately lies in its challenge to the fantasy of human independence. The desert does not simply test humanity; it reveals the conditions upon which humanity has always depended.

In both Herbert's novel and Villeneuve's cinematic adaptation, the movement beyond the human is therefore not a rejection of humanity. It is a movement beyond the assumption that humanity exists separately from the material and ecological world. The posthuman subject emerges when the boundaries of the autonomous self become permeable. Vulnerability is the recognition of this permeability. And sustainability becomes the ethical possibility of living within it.

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