

Geographical Aspects of Open-World Video Games

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Pablo Fraile-Jurado 

Abstract

In recent years, open-world environments in video games have become increasingly popular and immersive. Millions of players are able to explore virtual landscapes that resemble the real world, yet significant differences exist. This study investigates the geographical accuracy of 15 open-world video games. The virtual landscapes in these games were analyzed for horizontal distance compression, increased slopes, idealized climate, simplified vegetation and water features, underpopulation, and spatial segregation of ethnic minorities. The findings show significant differences between the games in terms of their geographical accuracy, with some exhibiting a more realistic representation of the natural and cultural environment compared to others. This study sheds light on the relationship between virtual landscapes in video games and our perception of the real world, offering new insights into this rapidly growing field.

Keywords

video games, landscape, open world, geography, relief

Introduction

Video games have become an increasingly important aspect of modern society, both in terms of entertainment and economic impact. According to a recent report by the Entertainment Software Association (ESA), the global video game market was valued at \$159 billion USD in 2020 and is expected to continue expanding. Adolescents, in particular, spend a significant amount of their leisure time playing

Departamento de Geografía Física y A.G.R. Universidad de Sevilla, Seville, Spain

Corresponding Author:

Pablo Fraile-Jurado, Departamento de Geografía Física y A.G.R. Universidad de Sevilla, C/ María de Padilla s/n, 41004, Seville, Spain.

Email: pfraile@us.es

video games, with studies estimating an average of 6–9 h per week spent playing (Gentile 2011), which is more than the time spent on other leisure activities such as watching TV or socializing with friends.

Studies have shown that young people today are spending less time outdoors compared to previous generations (Pergams & Zaradic, 2008, Gray, 2011). Schwarzfische et al. (2020) found that children spend more time watching screens than playing outside, especially in low and middle-income families, while Seguin et al. (2021) linked excessive screen time to parental stress. This change in behavior raises concerns about a lack of connection with nature and a potentially limited understanding of the physical world. Furthermore, a significant portion of young people's knowledge about different landscapes may come from playing video games, which may not necessarily be an accurate representation of reality.

Open-world video games offer the most complex representation of the real world in the entertainment industry. An open-world video game is a type of video game where the player is free to explore a virtual world and engage with various activities without linear restrictions, allowing for nonlinear gameplay and greater player autonomy in a virtual environment that resembles the real world (Juul, 2011). However, it is important to note that open-world video games may not always be an accurate representation of reality. Many open-world games feature fictional elements or locations that are not based on real-world counterparts, and even in games set in real locations, there may be significant differences between the virtual world and actual location (Denham & Spokes, 2021). These differences may not be immediately recognizable to players, especially those with limited experience in the outdoors (Salen & Zimmerman, 2005).

While the representation of the world in video games has improved over the years, it is worth noting that limitations in computational power can still impact the level of detail and accuracy that can be achieved. In some cases, developers may have to simplify or even sacrifice geographical accuracy to ensure the game runs smoothly on various hardware configurations. This is particularly true in open-world games, where the size of the game world can be a limiting factor. Despite these limitations, this study provides a comprehensive evaluation of the geographical accuracy of open-world video games, offering valuable insights into the current state of the industry.

New technologies, from images generated by artificial intelligence to new worlds developed in video games, have altered the spatial consciousness of the viewer (Ash, 2009). Defining the relationship between these perceived new worlds and reality is a task for many disciplines, including geography, especially when certain boundaries are sometimes unclear (Feldman, 2018). Geography has traditionally focused on describing and comprehending physical and human features of the world. The rise of open-world video games highlights the need for geography to describe and analyze virtual environments, as many individuals spend significant time interacting with them. Few studies have addressed this topic, making it crucial for geography to rigorously describe and understand these virtual environments and distinguish between real and fictional landscapes in the games, which might be partly due to the fact that the scientific perspective of analyzing video game landscapes is unusual for most geography journals.

Previous research in video games has mainly focused on the general geographic aspects rather than specifically analyzing the representation of territorial elements such as terrain, water, climate, and population. Only a few studies, such as [Ash and Gallacher \(2011\)](#) and [Dubois et al. \(2021\)](#), have explored the representation of tourist elements and player expectations related to the destinations in video games. However, this field of research is not well developed in academic studies.

Research on the realism of video games set in different historical eras has been conducted by several authors ([Shaw, 2015](#), [Michael, 2021](#), [Mukherjee, 2017](#), [Ramos, 2018](#), [Neumann, 2019](#), [Testi, 2020](#)), but these studies tend to focus more on historical events and characters rather than on the landscape aspect.

The study of open-world video games is often approached from an educational perspective ([Egenfeldt-Nielsen, 2006](#)). In both secondary education and universities, many authors have recognized the teaching potential of video games set in different historical periods ([Otaño & Mendaza, 2018](#), [Guerra Antequera & Sanz Ramos, 2017](#), [Gilbert, 2019](#)) and emphasized the importance of highlighting historical inaccuracies, which are also equivalent to geographical inaccuracies in the present study.

The study of [Scarlett \(2015\)](#) aimed to examine the geographical elements in the sandbox video game Minecraft from an educational perspective. Nevertheless, it did not delve into the analysis of territorial elements, which is the main focus of the current study. Several authors have highlighted the issue of ethnic spatial segregation in video games, with the Grand Theft Auto series being a significant source of violent exposure for players, particularly minors, as warned by [DeVane & Squire \(2008\)](#), [Polasek \(2014\)](#), [Coynne & Stockdale \(2021\)](#), [Barret \(2006\)](#), and [Teng et al. \(2011\)](#). However, other violent games receive little academic attention with few exceptions such as the works by [Patterson \(2016\)](#), [Sloan \(2015\)](#), and [Wills \(2018\)](#) focused on Far Cry saga and other studies.

Objectives

The analysis of virtual landscapes in open-world video games is crucial for geography as it enables the study of a significant aspect of contemporary human–environment interaction, given that millions of people engage with these landscapes on a daily basis, representing for many their primary relationship with the natural environment. Therefore, the objectives of this paper are to: (1) analyze the virtual landscapes in open-world video games and compare them to real-world landscapes and (2) evaluate the accuracy of the geographical representation in 15 video games and determine the most scientifically accurate representation of reality.

Methodology

The analysis of the representation of territory in open-world video games was the first of the objectives of this study. For this purpose, a selection of 15 commercially successful console games with diverse locations and historical settings was made.

The maps of these games were explored in-depth through gameplay, and a literature review was conducted to gather information from various sources, including scientific journals, specialized magazines, podcasts, and YouTube videos. Through this methodology, the virtual landscapes of each game were compared to real-world landscapes to find the main characteristics of virtual world environments, allowing for a comprehensive analysis of the geographical accuracy of these virtual environments.

To accomplish the second objective of this study, a panel of experts evaluated videos and images from each of the 15 selected games to determine the accuracy of their geographical representation. The panel consisted of eight experts covering a wide range of topics, including Geography, Geology, Environmental Science, Economics, Demography, and Video Games, which allowed for an objective assessment of the selected variables in each video game.

Nine variables were selected for evaluation, including map size, speed of transit, relief, climate, water, vegetation, population density, population distribution, and land use. Descriptive photographs and videos of each video game were provided to each expert, who individually rated the variables on a Likert scale (Joshi et al., 2015) after a preparatory meeting was held to unify the evaluation criteria.

To create a relative index, the scores for each variable were assigned based on the game with the most accurate representation of reality receiving a score of 5 and the game with the least accurate receiving a score of 1 (Table 1). To calculate the mean of each variable assessment for each game, the highest and lowest value provided by the expert panel were discarded, and the average of the remaining values was used, rounded to the nearest whole number.

The final scores for each game were calculated as the average of the variables without weighting, and the results were presented in the form of radar charts. It is worth noting that video games set exclusively in urban environments were evaluated separately as they could not be assigned values for environmental variables.

Data

Due to the vast number of video games that could be considered for analysis, a sample of 15 open-world games was selected for this study (Table 2). These games were played on a PlayStation 4 (PS4) console and were selected based on their diverse representation of real and fictional locations. The choice of using the PS4 as the platform for this study was motivated by its accessibility and affordability, as the research was carried out without specific funding. It should be noted that the choice of this platform was not based on any inherent advantage or disadvantage over other gaming platforms. The 15 games analyzed were considered AAA, meaning they had high production values and large development budgets. The criteria for choosing the games included not only their high popularity but also the diversity of landscapes, including urban, rural, and natural areas, as well as their belonging to different biomes such as taiga, Mediterranean, tropical forest, jungle, or desert. Due to the limitations of the study, some highly popular games were excluded. The 15 games were:

Table 1. Criteria for Assigning Values to Each Item on the Likert Scale for the Nine Variables.

Variables	Criteria for 1	Criteria for 5
V1: Map size	Small, limited exploration area	Large, extensive exploration area
V2: Transit speed	Fast, limited detail, walking exploration	Slow, high level of detail, car or fast vehicles exploration
V3: Realism of terrain	Inaccurate, unrealistic features, polygonal shapes	Accurate, consistent with surroundings, depiction of sediment strata, deposits at mountain basins
V4: Verisimilitude of climate	Unrealistic transitions, limited weather types	Smooth transitions, diverse weather types, existence of seasons as time passes
V5: Verisimilitude of waters	Unrealistic currents, poor wave representation	Realistic currents in valley bottoms, detailed wave representation
V6: Realism of vegetation	Inaccurate individual plant representation, unrealistic distribution	Precise depiction of individual plant representation, realistic distribution of herbs, shrubs, and trees, high diversity
V7: Realism of population density	Unrealistically low population density	Plausible population density
V8: Realism of population distribution	Unbalanced, extreme segregation of ethnicities and social classes by neighborhoods	Balanced, realistic distribution
V9: Realism of land use	Extreme rural–urban transition, limited residential areas	Soft rural–urban transition, significant residential areas

Assassin's Creed Odyssey (ACOd) is set in ancient Greece and features a highly detailed and diverse landscape. The game's world is designed to closely resemble the real-world geography of ancient Greece and the Aegean Sea, including famous landmarks such as the Parthenon in Athens and the island of Delos.

Assassin's Creed Origins (ACOr) is set in ancient Egypt and features a highly detailed and realistic world, including famous landmarks such as the Sphinx, the pyramids of Giza, and the city of Memphis.

Far Cry 5 (FC5) takes place in the fictional Hope County, Montana and features a diverse range of landscapes that bear resemblance to the real-life topography of Montana.

Far Cry Primal (FCP) is set in the prehistoric era and features a rich and detailed landscape inspired by prehistoric regions of Europe and Central Asia.

Grand Theft Auto V (GTAV) is set in the fictional state of San Andreas, which is modeled after California and Nevada. The game features a wide range of landscapes, including urban areas, beaches, mountains, and deserts.

Table 2. Analyzed Video Games, Release Date, PS4 Version Date, and Developer Company.

	Released date	PS4 version	Developer
Assassin's Creed Odyssey	2018	2018	Ubisoft
Assassin's Creed Origins	2017	2017	Ubisoft
Far Cry 5	2018	2018	Ubisoft
Far Cry Primal	2016	2016	Ubisoft
Grand Theft Auto V	2013	2014	Rockstar Games
Kingdom Come Deliverance	2018	2018	Warhorse Studios
Red Dead Redemption 2	2018	2018	Rockstar Games
Riders Republic	2021	2021	Ubisoft
The Crew	2014	2014	Ivory Tower/Ubisoft
The Elder Scrolls V: Skyrim	2011	2016	Bethesda
Watch Dogs 2	2016	2016	Ubisoft
Spiderman	2018	2018	Insomiac Game/Sony Interactive
Sleeping Dogs	2012	2017	Square Enix
Yakuza 6	2016	2016	Sega
Ghost of Tsushima	2020	2020	Sucker Punch Productions/Sony Interactive
Death Stranding	2019	2019	Kojima Productions/Sony Interactive

Kingdom Come Deliverance (KCD) is set in medieval Bohemia and features a landscape based on real-world locations and historical architecture.

Red Dead Redemption 2 (RDR2) features a highly detailed and diverse landscape, which closely resembles real-world geographic features of the Western and Southern United States.

Rider Republic (RR) is set in national parks and landmarks such as Yosemite, Yellowstone, Bryce Canyon, Zion, and Grand Teton. The game allows players to explore these iconic landscapes and participate in a variety of outdoor activities.

The Crew (TC) is set in the United States and features a vast, open-world map that allows players to drive across different regions of the country, including cities, rural areas, and natural landscapes such as deserts, forests, and mountains.

The Elder Scrolls V: Skyrim (SKY) is set in the fantasy land of Tamriel and features a highly detailed and diverse taiga and tundra mountainous landscape with medieval towns.

Watch Dogs 2 (W2) is set in a fictionalized version of San Francisco, California and features a realistic representation of the city, including recognizable landmarks.

Spiderman (SPI) takes place in a fictionalized version of New York City and features a vast and detailed recreation of the city, with recognizable landmarks such as the Empire State Building and Central Park.

Sleeping Dogs (SD) is set in Hong Kong and features a highly detailed representation of Hong Kong's urban landscapes.

Yakuza 6 (Y6) is set in Kamurocho, a fictional district based on Tokyo's red-light district of Kabukicho, and features a highly realistic depiction of Kamurocho's urban landscape.

Ghost of Tsushima (GoT) is set on the island of Tsushima during the first Mongol invasion of Japan and features a highly detailed and diverse representation of the island's landscapes.

Death Stranding (DS) is set in a post-apocalyptic world and features a highly diverse representation of the game world's landscapes, including mountains, deserts, and cities.

Results

Characterization of Video Game Landscapes

Eight main geographical characteristics were found and are subsequently detailed:

1. Selective horizontal scaling reduction. Selective horizontal scaling reduction is a common feature among all the analyzed video games, which tend to represent much larger territories using relatively small areas, typically around tens of square kilometers. This phenomenon can be quantified in video games that aim to accurately depict existing real-world locations (Figure 1). However, this scaling reduction is also present in the other analyzed games. For instance, in RDR2, the distance in the landscape between distant territories (from Louisiana to the deserts of the Western United States) is limited to less than 15 kilometers in-game, taking approximately 25 min to travel on horseback. Additionally, this feature is consistent in terms of horizontal scale but not vertical scale. Although data is scarce, the relief in the games appears to maintain a rigorous scale. The combination of reduced horizontal scale and maintained vertical scale results in a more abrupt relief in the games than in reality, as discussed later in this section. Moreover, the representation is selective, focusing on the most visually striking elements and those that facilitate gameplay at the expense of less interesting territories. For instance, TC allows the player to travel from the East Coast of the US (New York, Washington, Miami) to the Rocky Mountains (Canyonlands, Salt Lake City) without crossing the vast plains of the Midwest. To improve the section's coherence, further expansion of the description of selective horizontal scaling reduction is recommended.

In ACO_r and ACO_d, cities are portrayed as occupying a smaller area than they did during the historical periods they represent. This scaling down is particularly evident in the reduced distances between cities, which allows players to traverse long distances quickly. For instance, it is possible to travel from Sparta to Athens on horseback in less than 15 min. This phenomenon is likely due to the need to prioritize gameplay over geographical accuracy, as vast, homogenous areas such as residential neighborhoods would make the game tedious.



Figure 1. Evidences of horizontal scaling reduction in SPI (views of Empire State Building from Chrysler Building), ACOd (views of Athens), and a section of the map of RR, where boundaries between Canyonlands and Sequoia National Parks can be observed.

Similarly, video games that exclusively depict urban environments, such as SPI, SD, and W2, prioritize the representation of recognizable landmarks and elements that characterize the city. For instance, the New York City of SPI features iconic structures like the Empire State Building, Chrysler Building, and Lincoln Library. However, the quantity of buildings, particularly residential ones, between these landmarks is substantially reduced compared to reality. This reduction is likely motivated by gameplay considerations, as a more accurate representation of the city would entail rendering vast, homogenous areas that may not be compelling for players to explore.

2. Vertical scale. In open world games, the terrain is an essential element that serves two main functions. The first is to act as boundaries for the open world itself. One of the main challenges in designing an open world game is how to set limits to a world that the player perceives as open despite being spatially limited. In some cases, this is solved with an invisible barrier that prevents the player from moving outside the map, sometimes indicated with a warning on the screen (e.g., SPI). However, it is very common for games that include mountainous elements to include steep terrain that impedes passage, thus camouflaging the game's outer boundary and integrating it into the landscape. This phenomenon can be observed in games such as RDR2 (Figure 2), etc.

The study found that the terrain in open-world video games often serves as a barrier, limiting the player's movements. This can be seen in games like RDR2 where players must go through canyons, or in games like SKY where the terrain forces players to take



Figure 2. Vertical limits in the map or RDR2.

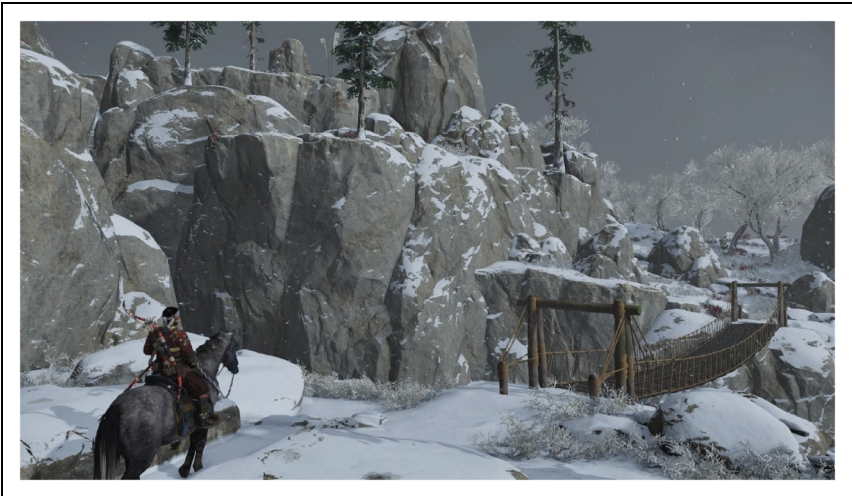


Figure 3. Vertical limits in GoT.

a certain path to reach their destination. It is important to note that the use of terrain as a game design element does not always prioritize spatial accuracy. In many cases, game developers prioritize gameplay over spatial realism when designing the terrain. For instance, game designers may intentionally create barriers to guide players toward specific areas or force them to take a certain path to achieve game objectives. In other cases, developers may use the terrain to create interesting and challenging encounters with enemies or discoveries. This approach to terrain design can enhance the player experience by adding an element of surprise and challenge, but it can also result in a less realistic representation of the game world.

Although terrain, or relief, often plays a limiting role in open-world video games, there are games that allow for easy ascent to virtually any point on the map, as is the case with the Assassin's Creed franchise. While relief is an obvious and highly vertical element in relation to the real world, traversing it is greatly facilitated (by riding, walking, or directly climbing) in such a way that any point on the map can be reached, with few areas that cannot be climbed. A similar case is that of GoT, in which, although there are many steep terrains, developers have marked points that allow for climbing every few meters, rendering its role as a limiting element null (Figure 3). In this case, it is likely that relief is used as a separator of contiguous territories with different designs.

3. Geomorphology. In open world video games, geomorphology plays a significant role in creating believable landscapes for players to explore. The use of relief, while often used to create vertical elements in the game, also serves to add veracity to the landscapes observed by players as they move through the game's map. However, the creation of different types of relief that may appear believable at first glance does not necessarily mean that they are accurate from a geomorphological perspective.

It is common for several analyzed games to feature elements with difficult geomorphological explanations. The most frequent of these are vertical walls, which in only one game examined (SKY) present deposits such as glacis or cinder cones, while in the rest (ACOr, ACOD, etc.) they typically connect to plains without any visible rock fragments.

Additionally, some games stand out for their geomorphological verisimilitude. For example, in the case of RR, the nature of the game itself leads to this outcome, as it is set entirely within US national parks and generally depicted with a high degree of realism. In this sense, the hoodoos of Bryce Canyon National Park are particularly noteworthy (Figure 4), as they not only appear in the game but also the deposits formed at the base of the slope as a result of erosive processes higher up. Similarly, this game accurately represents other territories such as Yosemite or Grand Teton, while simplifying the horizontal sedimentary strata of Canyonlands National Park, where they only appear in the park's plain areas.

It is worth noting that GTAV also stands out for its accurate modeling of mountains, sediment of different thicknesses and textures, and regional geomorphological coherence (Figure 5). The game takes place on an island with a prominent anticline that is the highest point in the game.

In general, it can be stated that the geomorphological realism of games when developed in sedimentary basins is notably higher than when they are developed in other types of landscapes, beyond the exceptions mentioned. Attention should be paid to the scalar issue. The volumetry represented in each game starts with elements of metric range. The representation of submetric elements is usually carried out by using textures, that is, images of particles of different thickness, color, and angularity that are superimposed on larger volumes, such as those used to represent any wall or floor. Therefore, it is completely impossible to interact with small particles despite



Figure 4. Hoodos of Bryce Canyon National Park in RR.



Figure 5. Mountains and rivers in GTAV.

them being visible. At most, when in some games (GTAV, FC5) some violent action is performed, such as shooting at this type of element, it is common for a cloud of dust and some particles to appear that apparently scatter from that place, without any modification of the landscape being observed afterward. ACOR is essentially developed in the desert, so for the player it is very frequent to move through areas without any vegetation in which the rocky substrate is completely exposed. The quality of the textures used is so high that it is generally difficult to observe the absence of a proper volume in

the submetric range particles, and it seems to be related both to the use of high-resolution images in the representation of textures and to a great volumetric complexity for the metric range particles on which they are represented. This efficiency in the use of this modeling system is a relatively recent phenomenon, since in older games like SKY, which opt for the same system, the desired effect is barely achieved, being very evident the scarcity of vertices in the modeling of metric range rocks, which causes the low-resolution textures by which they are represented to be visibly unrealistic.

4. Climate. The representation of the atmosphere, in terms of how it filters light and reflects different particles and colors while interacting with elements of the game's environment, is one of the most common examples of the graphical power of each new generation of consoles and video games.

Climate is an element of the environment that presents a certain intangibility from the standpoint of immediacy in a video game, as the concept of climate as the average state of the atmosphere over a certain place is not closely related to the speed at which games occur. However, climate is present in two ways: in the types of weather in the games and in the landscape, particularly in vegetation.

It is common for almost all games to feature a succession of dry, stable, and sunny weather types, probably due to the fact that they allow for better player visualization of the environment. Precipitation is an occasional element that does not seem to have any relation to the vegetation of the environment. It tends to occur either due to demands of the video game's plot (increasing difficulty by reducing visibility) or randomly. Random precipitation in video games refers to weather events that occur unpredictably and without any relation to the game's plot. These events can include rain, snow, or storms with strong electrical activity. In random precipitation, storms with strong electrical activity are very common. In mountainous areas, precipitation tends to be exclusively snow (as in RDR2 and FCP) if it occurs. The limit of permanent snow in mountainous areas is clear in all games and does not change regardless of the date in the game. It usually presents a very sharp contrast that is accompanied, within a few meters, by a type of weather that is radically different from what is observed a few dozen meters below (Figure 6).

Wind is an element that rarely appears in video games. Of the games consulted, it plays an essential role in GoT, where it is a fundamental element of the landscape due to the continuous movement of vegetation and the direction of the wind being used as a guide for the main character's path. Additionally, GoT seems to take place in a permanent autumn, which may be due to the need to showcase the effects of wind in gameplay.

The fog has also been used by some open-world games as a means to avoid drawing textures for distant objects, thus allowing for a more efficient use of the game's system. This technique, known as fog of war, allows for a more realistic representation of visibility.



Figure 6. Clear boundaries of snow in SKY.

5. Waters. The representation of continental waters in open world games is relatively common. It is very common for a river to appear in each watershed, whose flow is always completely constant, regardless of the season or the precipitation that has been observed previously. A common error in all the games consulted is that rivers practically lack tributaries, so the drainage network is completely linear. Due to the strong slopes of open worlds, the water flow speed is often very high in all the rivers observed. Both waterfalls and smaller water jumps are often seen.

The presence of low-lying areas is merely testimonial in most games, except in where, despite being a small island, rivers tend to have a very smooth profile with calm waters.

In RDR2, several channels are also observed that are never occupied by fluvial waters (Figure 7) regardless of weather conditions, although the representation of the channel and floodplain is similar to those found in California, Arizona, or the Mediterranean area.

In areas where the relief presents endorheic configurations, lakes appear, often of great depth. Both lakes and the rare swamps (GTAV) always show exactly the same level. It is common for lakes located in mountainous areas to appear with a layer of ice that rarely covers the entire surface of the lake.

The marine waters often exhibit short-period and high-amplitude waves, resulting in a highly rough sea surface. This is the case in video games such as GTAV, AC Origins, and ACOd. The wave breaking is one of the least realistic elements in the representation of open-world video games, and its quality varies significantly depending on the production year of the game. In SKY (first edition in 2011), it is limited to a pale



Figure 7. A river in RDR2.

sheet that overlays the sea surface advancing inland and then receding, while in ACOd and GTAV, the wave complexity is much greater (Figure 8). In any case, the coasts of all games have in common that the waves break in spilling, probably because the difficulty of simulating a plunging wave in three dimensions is enormous compared to what the game can handle. No movement of tide is observed in any game, and except in the case of GTAV, whose southern beaches measure hundreds of meters in width, the narrowness of the rest of the beaches seems to suggest micromareal regimes in all cases. In coastal areas where cold climates are observed, icebergs are very common (Figure 9), consistent with the observed tendency to exaggerate climates.

6. Vegetation. Vegetation plays a crucial role in open world video games, fulfilling several different functions. Firstly, it allows for player immersion in the landscape by providing cues to the player about the climate and environment in which the game takes place. The presence or absence of certain vegetation types can indicate to the player whether they are in a tropical, arid or temperate environment, for example.

Additionally, vegetation can also act as a limiting factor in player movement, similar to the way in which terrain does. While this is less common, some games impose restrictions on player movement through the use of dense bushes or other types of foliage. For example, in the game KCD, the boundaries of the game world are primarily made up of thick, impenetrable bushes (Figure 10).

The quality of vegetation representation is also an important factor in distinguishing one video game from another. This refers not only to the complexity of the polygonal structures and textures used to design trees and bushes, but also to the accuracy of the

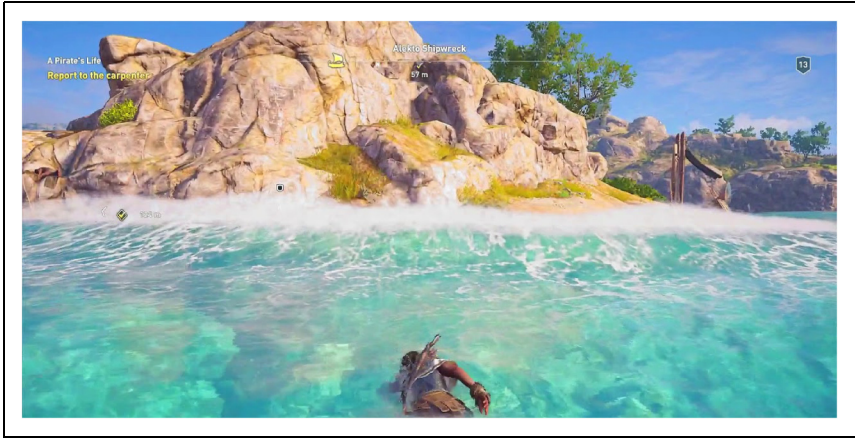


Figure 8. Waves breaking in ACOd.



Figure 9. Icebergs in the shoreline in SKY.

representation of different vegetation types and species. A game with a wide variety of detailed and realistic vegetation can add to the sense of realism and immersion for the player, and can help to make the game world feel more alive and believable.

7. Land uses. In a study of 15 open world video games, it was found that the proportion of land uses represented in the games is vastly different from reality. Urban uses and artificial

structures are significantly more prevalent in the games than they are in real life. For example, in GTAV, which is set in the United States, the proportion of urban land uses is much higher than the actual proportion of urban land in the country.

Natural land uses are the most common in the games, however, there is a distinct underrepresentation of agricultural land uses. This is particularly striking in games such as SKY and GTAV, where agricultural activities are almost entirely absent, providing a false impression of the actual distribution of land uses.

However, not all games were found to have such skewed representations of land uses. For example, Assassin's Creed, which takes place in various historical settings, shows a slightly more realistic approach to land use distribution. In the game, farms and agricultural uses are common around cities and towns. However, there is still a lack of balance in the representation, as large cities such as Athens have a similar number of farms and fields as smaller towns.

It is worth noting that the proportion of land uses represented in the games varies greatly between different regions and countries. In games set in European countries, for example, the proportion of urban land uses is lower than in games set in the United States, while the representation of agricultural land uses is higher.

The study found that open-world video games give an inaccurate view of how land is used. Cities and man-made structures are shown more often than they really are, while farms and agricultural land are shown less often. This can cause players to have an incorrect understanding of how land is used in reality.

Most of the land use in these games does not change over time and does not show the effects of time passing. This means that seasonal changes and dynamic farming



Figure 10. A forest in KCD.

activities are not shown. One exception to this is the game *SPI*, which does show the effects of different seasons on the landscape and has different visuals and gameplay depending on the time of year. Some other games, like *SKY*, show different seasons depending on the location.

8. Population. Population is consistently underrepresented according to various unofficial websites consulted for NPC data. The population density was calculated by dividing this number by the area. In the case of *SKY*, the game's representation of population has an average density of only 1 person per square kilometer, while the actual population density of medieval England, where the game seems to be set, was estimated to be around 5–10 people per square kilometer.

Similarly, in *GTAV*, it was found that the game's representation of population had an average density of only two people per square kilometer, while the actual population density of the Los Angeles area, where the game is set, is around 2,7000 people per square kilometer. Other games such as *FC5* and *ACOr* also showed a significant underrepresentation of population compared to actual population densities of the regions where the games are set.

This underrepresentation of population in open-world video games can be attributed to the game developers' focus on gameplay and visual aesthetics rather than accuracy in representing population densities. Additionally, the limitations of current technology also play a role in the underrepresentation of population in these games.

Another key aspect of population representation in video games is the distribution of population. Cities in video games often have a disproportionate percentage of the total population compared to real-world cities. This is particularly pronounced in games that take place in the past, when rural populations were larger than urban populations. This phenomenon is likely due to the game developers' focus on creating visually impressive and bustling city environments for players to explore, rather than accurately representing historical population distribution patterns.

The representation of ethnic groups in video games is a significant aspect to consider. There are often patterns in the distribution of different ethnicities in the games, with some areas being associated with certain groups. Some video games like *GTA* saga have been criticized for portraying ethnic minorities in stereotypical and limited ways, while others have been praised for their more nuanced and respectful representation. These representations can impact players' perceptions and attitudes toward different ethnic groups. It is widely recognized that there is a lack of representation and diversity in video games, and that what representation exists often reinforces harmful cultural prejudices.

Ranking the Analyzed Video Games

The following section presents the ranking of the analyzed video games based on their depiction of various geographical features and the degree of realism in their virtual

environments. The results are summarized in Table 3 and Table 4 and in Figures 11 and 12.

The results obtained for the various games were varied, with some games performing particularly high and others performing below average (Figure 11). The games that obtained the highest scores were KCD and DS, with average scores of 4.11 and 4.17, respectively. KCD scored highly in several variables, including relief, waters, vegetation, and land uses. The relief was rated with the highest score, and the waters and vegetation were also rated highly, indicating a detailed representation of these features. The population distribution and density were also rated highly, indicating a realistic depiction of the population in the game's setting. The map size and speed transit variables scored slightly lower than the other variables.

The games with the lowest scores were TC, W2 and RR, with average scores of 1.44, 2.78 and 2.00, respectively. These games were marked by obtaining low values in majority of categories. For example, TC stands out for its expansive map size, which earned a high score of 5 out of 5. However, the game performs poorly in all other variables, with the lowest scores in speed transit, relief, climate, waters, vegetation, population distribution, population density, and land uses.

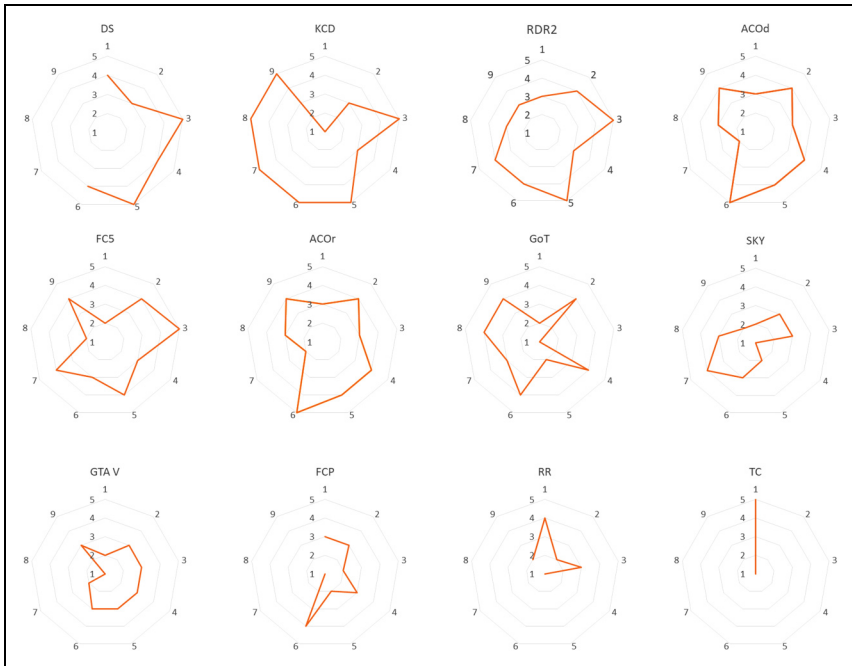


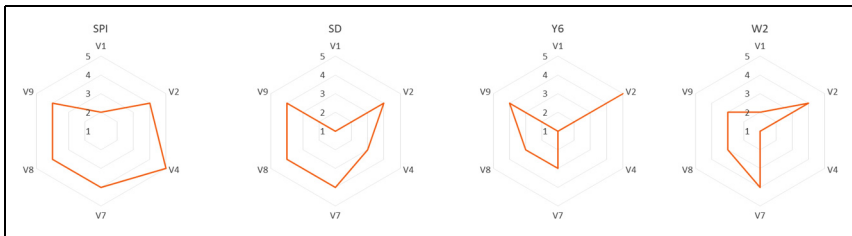
Figure 11. Radar charts of the 12 nonurban video games analyzed, ordered by their average punctuation.

Table 3. Results of the Analysis of the Nine Variables.

	ACOd	ACOr	DS	FCP	FCS	GoT	GTAV	KCD	RDR2	RR	Skyrim	TC
Map size	3	3	4	3	2	2	2	1	3	4	2	5
Speed transit	4	4	3	3	4	4	3	3	4	2	3	1
Relief	3	3	5	2	5	1	3	5	5	3	3	1
Climate	4	3	4	3	3	4	3	3	3	1	1	1
Waters	4	4	5	2	4	2	3	5	5	1	2	1
Vegetation	5	5	4	4	3	4	3	5	4	1	3	1
Population distribution	2	2		1	4	3	2	5	4		4	1
Population density	3	3		1	2	4	1	5	3		3	1
Land uses	4	3		4	4	4	3	5	3	2	2	1
AVERAGE	3,56	3,33	4,17	2,38	3,44	3,11	2,56	4,11	3,78	2,00	2,56	1,44

Table 4. Results of the Analysis of the Six Variables Studied in Urban Games.

		Y6	W2	SPI	SD
Map size	V1	1	2	1	1
Speed transit	V2	5	4	4	4
Climate	V4	1	1	5	3
Population distribution	V7	3	4	4	4
Population density	V8	3	3	4	4
Land and uses	V9	4	3	4	4
Average		2.83	2.83	3.67	3.33

**Figure 12.** Radar charts of the four urban video games analyzed, ordered by their average punctuation.

Other games like GTAV, RDR2, ACOd, and ACOr had average scores ranging between 2.56 and 3.56 and showed mixed results in terms of map size, population distribution, and relief. ACOd and ACOr had similar scores, with the former being better rated for vegetation, while the latter scored higher in climate. RDR2 presents a highly diverse and detailed landscape, featuring a wide range of geographic features such as mountains, forests, and water bodies. However, the game scored lower in terms of population density and land uses.

GoT, SKY and FC5 were also in the middle range, with scores between 3.11 and 3.44. They were characterized by their average map size and vegetation, while the relief varied depending on the game. The water and population density were also important factors that contributed to the scores.

The results regarding the calculation of the quality of each game in its representation of exclusively natural elements (relief, climate, water, and vegetation) highlight the games DS (4.50) and KCD (4.50), slightly above RDR2 (4.25). The two games that worst represent these natural elements are TC (1.00) and RR (1.25).

Regarding video games that take place in exclusively urban environments (Figure 12), the scores were quite similar, with SPI (3.67) standing out slightly above Y6 (3.40), SD (3.20), and Watch Dogs (3.20). In terms of map size, Y6 and SD obtained the lowest score of 1 out of 5, while W2 and SPI scored 2 and 1, respectively. Regarding speed transit, all games scored relatively high, with Y6 obtaining the

highest score of 5, followed by SPI, W2, and SD. For climate, W2 and SD scored 3, while Y6 and SPI obtained the lowest score of 1. In population distribution, SD and SPI scored the highest with a 4, while Y6 and W2 scored 3 and 4, respectively. As for population density, all games scored relatively low, with Y6 and SPI obtaining a 3, and W2 and SD scoring 4. Finally, in land uses, Y6 obtained the highest score of 4, followed by SD and SPI with 4, and W2 with 3. Overall, these games present a relatively moderate average score, ranging from 2.83 to 3.67, partially explained by the small map size, in comparison to the games of [Table 2](#).

Discussion

In the study's first phase, aimed at identifying the general characteristics of the 15 video games' virtual territories, it is noted that the video games are influenced by the developers' need to offer a fast consumer product, leading to shortened distances and increased slopes. While realism is secondary to gameplay mechanics and plot, some games like RDR2 and KCD show a significant interest in appearing geographically accurate, reflected in longer travel times. The visual elements of the territory, such as terrain, vegetation, waters, and population, are given high priority, but variables such as climate and land use receive less attention. Despite the 15 games having a good visual representation of the territory, results show a diverse range of evaluations, both in average value and in each variable. This is due to the relative nature of the index, with a maximum and minimum value identified for each variable among the 15 games ([Ojeda et al., 2009](#)). The findings of the paper show that there is a trade-off between transit speed and level of detail in the virtual territories of the video games. Games like Y6 or KCD, which are characterized by slow transit speeds, are highly detailed, while TC, a pure driving game, has much lower levels of detail due to its high speeds that often exceed 150 km/h.

In the analysis of open-world video games, it is apparent that the accuracy of geographical aspects is often subordinate to the entertainment value and marketability of the game. However, there are notable exceptions to this rule, as some games prioritize attention to detail in their geographic elements as a unique selling point. Nonetheless, it is clear that for many games, the primary goal is not geographic accuracy, but rather creating an immersive and entertaining experience for players. Therefore, there seems to be a trade-off between accuracy and entertainment value, with developers striving to strike a balance between the two in order to create a successful and popular game. Within this balance between playability and unintended geographic accuracy, it has been noted that video games also give players a sense of power and control over the spatial form of the landscape. However, it is important to consider that video games reflect the moral ideologies of their producers and, therefore, limit or direct the types of lessons about the real world that players can learn.

The literature lacks discussion on class-based spatial segregation which is often evident in some of the analyzed games. For instance, in games such as GTAV and ACOd, a clear connection is made between poverty, marginalization, and crime in

economically deprived neighborhoods, potentially impacting players' perceptions. This aspect has been neglected in academic literature and deserves further investigation. On the other hand, Kühn et al. (2019) did not find significant negative effects of violent gameplay on any measures of aggression, interpersonal competencies, empathy, executive functions, or affect, providing robust evidence against the negative effects of long-term violent gameplay, as it is also supported by McCarthy et al. (2016).

Playing open-world video games provides the player with the perception of exploring spaces that have not been visited in real life. This phenomenon, within the diversity of territories and even historical periods such as those presented in only 15 video games in this study, offers enormous educational potential that is not ignored by the academic community (Aguilera & Mendiz, 2003, Wills, 2002, Egenfeldt-Nielsen, 2006, Scarlett, 2015). In this sense, it should be noted that it has already been demonstrated (Pingel, 2018) that familiarity with certain territories allows them to be incorporated into mental maps, especially in symbolic territories. It will still be necessary to incorporate the role of territories explored only virtually, such as those in video games, and the role that their geographical accuracy plays.

Conclusions

Open-world video games provide an extraordinary opportunity for immersion into diverse and unique geographical territories. However, these games often make geographical inaccuracies by prioritizing the gameplay mechanics and narrative elements over the accurate representation of the terrain. The elements that are treated with greater accuracy are usually the terrain and vegetation, which are more visually appealing than climatic elements such as climate and water. Despite this, the aspect that stands out the most is the shortening of distances between elements. This reduction of distances leads to an increase in slopes, which often can create a perception of a more challenging and exciting terrain for the player.

From the Physical Geography point of view, changes in vegetation and even biomes within a few kilometers are another uniqueness that must be taken into account when using these games for noneducational purposes. In human aspects, the distribution of population in some video games reveals a worrying spatial segregation of class and race. Not all games prioritize the landscape in the same way. Games such as RDR2 or KCD showcase open, realistic, and geographically accessible worlds. However, there are other games that prioritize gameplay over realism, resulting in less realistic representations of the landscapes. Games that take place exclusively in urban areas often show exceptional detail and great similarity to the cities they represent, although the size of the map is always very limited.

It is worth mentioning that the analysis carried out in this work only covers 15 widely distributed and successful video games from among thousands of releases in the past decade. Further studies are necessary to delve deeper into each of these elements for a better educational and social utilization.

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ORCID iD

Pablo Fraile-Jurado  <https://orcid.org/0000-0002-0382-0931>

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Author Biography

Pablo Fraile-Jurado is a full professor at the Department of Physical Geography at the University of Seville. He is the author of over 30 scientific articles and 70 conference communications. His main research focus is mapping sea level rise as a result of climate change, but in recent years he has added a line of research on geography education. He has participated in more than 12 scientific projects and has been teaching at the University of Seville since 2004.