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Gender Violence and the Construction of New Gender Identities: Roma Migrant Women's Lived Experiences in Romania and Spain

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KEYWORDS

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Romanian Roma women
migrants
Valencia region
Spain

ABSTRACT

Recent research indicates that there are critical physical, psychological, verbal and economic issues that shape the types of violence to which women are subject. This study analyses how Roma migrant women fall victim to domestic abuse, both in their home country (Romania) and abroad (Spain). Drawing on literature regarding violence against women, a survey (N=132) was conducted with Romanian Roma migrant women in Spain to understand the ways in which they reconstructed their gender identities in the face of violence. Further semi-structured interviews were undertaken with five Roma migrant women to determine the ways in which these women perceived the forms of violence to which they fell victim, what caused their partners to become perpetrators, and what roles their own families played in this scenario. The findings of our study reveal the inherent insecurities that violence has inflicted on our participants, unmask the destructive effects on the family unit, and explain how some of the interviewees were able to transcend their experience and initiate a process of resetting their gender identities. If the predominance of the traditional patriarchal structure of Roma society can be observed during the life experiences of the Roma women in Romania, the gender characteristics are changing among those Roma women who have migrated to Spain: there is a greater emphasis on a fairer distribution of domestic tasks, decision-making in the family, and their ability to adapt to new possibilities for professional development. The study concludes that although violence against Roma women is still a real issue in Spain, women are re-defining their gender identities to resist traditional patriarchal structures.

Introduction

The European Union (EU henceforth) considers that violence against women and girls is one of the highest forms of infringement of human rights, and implicitly, a systematic violation. The perpetrator is usually one's life partner and a staggering third of all women have experienced physical or sexual violence (Council of the European Union, 2022). The benchmark for international standards in the field of domestic violence started with the Istanbul

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Convention in 2014, and was ratified in 2017 by The Council of Europe convention, which was based on preventing and combatting violence against women and domestic violence (UN, 2022). The latest European Commission directive that actively challenges gender and domestic violence was launched in March 2022. It includes women's access to justice, the right to claim compensation, access to rape crisis centres and free of charge helplines (EU, 2022).

Recent studies on gender-based violence have also revealed that women suffer different forms of violence at home, at work and in society at large (Cantera, 1999; Cantera, 2005; Ferrer & Bosch, 2005; Alcañiz, 2015; Perrone & Nannini, 1995; Racz et al., 2022). However, the ways in which migrant Roma women experience this kind of abuse are still not dealt with in current literature.

Consequently, this study aims to identify to what extent the Romanian Roma migrant women have managed to reshape and reconstruct their gender identity in Spain, and what role played their previous perception of domestic violence in their attempt to make a significant change.

The key questions of the paper are:

a) How do the Roma migrant women in Spain reconstruct gender identity?
b) What are the significant lines of rhetoric on gender violence and how are these perceived from a diachronic perspective in Romania and in Spain?

This paper draws from recent debates in gender violence studies and migrant gender studies by placing the lived experiences of violence against Roma women.

The structure of this study has got three focal points. First, we will present the outlines of recent literature review which will set the theoretical foundation for our analysis, then we present our findings through interviews and finally examine the data in relation to known literature.

Gender-based violence and the Roma migrant women

In the international gender-based violence sphere (Cantera, 2007; Perrone & Nannini, 1995), we notice a consensus regarding abuse in the domestic and public space. It is perceived as a recurrent issue across all cultures, social classes, ethnic groups, religions and ages, and not surprisingly, as a violation of human rights. In order for us to understand better the features related to gender-based violence as rooted in domestic violence, we need to point to the United Nations' Beijing Declaration (UN, 1995) which states that „violence against women means any act based on gender that results in psychological, sexual, physical harm, including threats of such acts, deprivation of liberty" (p. 1).

There are many explanatory theories of domestic violence. The ideas of Perrone and Nannini (1995) for instance, come from the theories of gender-based violence, which state that domestic violence has complex forms of manifestations that interact with each other due to family dynamics; this entails that the family unit would undergo difficulties, but lack the communication skills to reach a consensus. The authors insist on the fact that the perpetrator actively refuse to take responsibility for their actions and suggests that the female victim adds to this form of abuse by being afraid to make a change, which inevitably forces her to remain confined in a toxic environment. This statement has been criticised by Cantera (2007), who focuses mainly on the aggressive conduct of the perpetrator against the woman, discarding the woman's side of inaction. Perrone and Nannini (1995) relate the thinking and behaviour of the aggressor to their inability to change, as society itself is limiting men's opportunities to make a substantial transition, such as are the ramifications of feminism.

From a biological point of view, Ramírez (2000) explains the process of domestic violence as a response to one's intrinsic survival instinct, as part of the biological makeup of men, as it is well-known that men tend to react more aggressively when their well-being is challenged. The same author gives examples of aggressiveness in different male animal species when faced with pressure and relates this to the lack or poor education that men receive, which could be a decisive factor in the development of domestic violence. Along the same lines, Booth and Dabbs (1993) analyse the testosterone level in men and the ways in which it affects their aggressiveness. The results reveal that there is a strong association between high testosterone and physical aggression in the man-woman relationship. As we are going to see later on, the present study indicates that there are ways to successfully change these aggressive impulses into initiatives, and make conscious efforts for personal development.

On the other hand, feminist theories of violence focus more on cultural analysis of violence. Male violence against women is seen as an abuse of power in a social structure that allows men to assault women (Walker, 2004). In this context, Vicente and Turinetto (2008) highlights male social privileges at the expense of females to maintain male superiority. This fact proves the importance of social exposure, education and interpersonal relationships. Therefore, in a society dominated by the male model, patriarchy renders women as an object of control and domination, where the „training" and „education" of a woman is part of a broad phenomenon produced and reproduced by the social structure of patriarchal sovereignty (Cantera, 2007; Hunnicutt, 2009).

Curiously enough, the mistreatment of women is seen as a socially accepted form of conduct in certain parts of the world; however, from an ideological and cultural point of view, this kind of behaviour can be reinforced in time, but fortunately, is prone to changing (Cantera, 2007). As the same author points out, domestic violence is a public, social, political and moral problem. A crucial point in this case is the maltreated woman's resilience in the face of an abusive relationship, and her ability to become economically and psychologically independent. Domestic violence, as a byproduct of the evolution of gender dominance, can be transformed and substantially reduced if early intervention is made in society's education (Cantera, 1999). Domestic violence may also appear in the social and geographical space: it does not have concrete social classes, nor does it belong to a specific ethnic group, nor is it directly related to one's faith, cultural background or economic status.

Vicente and Turinetto (2008) claim that any violent behaviour is intentional and has a clearly predetermined objective (i.e., physical, psychological, economic, and sexual abuse). For this reason, domestic violence aims to control the victim and/or create a sense of fear (Ferrer Pérez & Bosch Fiol, 2005). In the same context, Vicente and Turinetto (2008) reject the generational theory and insist on the fact that the aggressor cannot be exempted from social responsibility, even if domestic violence is perpetuated from generation to generation and is accentuated due to the power imbalance in the couple's relationship.

Ecological theories of violence examine the social context to understand the factors that influence domestic violence. According to this theory, we could look into several angles:

- the macrosystem: includes all forms of social organization, as well as cultural and ideological values of a society that fuel domestic violence (Bronfenbrenner, 1977).
- the exosystem: it consists of the social relations that are established between an individual and a public institution (school, church, workplace, social networks, mass media) that may help perpetuate domestic violence (Belski, 1980). In this context, we can include the following factors: the ineffectiveness of laws in the face of gender and/or domestic abuse, the scenes of violence prevalent in mass media, and female economic autonomy (De Maris et al., 2003). The number of children per family unit may also add to the pressures faced by the married couple (Flake, 2005).
- the microsystem: refers to the area closest to the person and their relationships (family, friends, spouse), which can fuel domestic violence (Heise, 1998). In this context, the theory explains marital conflicts regarding the fair distribution of domestic tasks, sets the scene for drug addiction and challenges the education the woman receives. In the face of these problems, Belski (1980) relates anger outbursts to reduced stress tolerance. Regarding the relationship between violence and alcohol consumption, Carlson (1984) insists on alcohol being a risk factor that enables domestic violence. Combined with macro-systemic elements, such as an individual's culture, deep-rooted beliefs, etc., it can generate different forms of violence in the marital space.
- the individual level: it focuses on the personal set of beliefs (including self-image) that the individual brings to the relationship. The biological, cognitive, and emotional characteristics that intervene in interpersonal relationships are related to the system of values and beliefs received by the perpetrator in the family before marriage (Carlson, 1984).

Finally, violence related to stress theories are also relevant in this case. For instance, Mullender (2000) argues that men become violent due to the pressure of social problems (poverty, lack of jobs) and analyses the behaviour of aggressors in a situation of social equality, demonstrating that it is men who usually attack women, even in situations of social equality. Analysing gender structures, social order and social inequalities, the gender perspective considers that gender, class and ethnicity overlap to generate social hierarchies and inequalities. These open up the possibility of substantial changes in different social contexts. However, according to the same author, they also allow social identities to be redefined in terms of class, rather than ethnicity or gender.

Chodorow (1995) on the other hand, believes that political and cultural dynamics are responsible for the perception of people's multiple social identities and the various social divisions produced in society. In this sense, the author emphasises that: "it is crucial ... to recognise that the ideologies of difference that define us as women and men, like inequality itself, are socially, psychologically and culturally produced by people living and creating their social, psychological and cultural worlds." (p. 48).

Continuing the theoretical analysis of gender relations, we may notice a tendency to classify certain theoretical viewpoints. Within the specialised literature on Roma women, there is a separation and a stratification of social theories about gender, as follows:

The theory of gender relations is dominated by traditional models, a concept supported by Magyari-Vincze (2001). The author argues that the principles of gender-based allocation of domestic tasks in the family result in the inequality between women and men. The author also insists on the unfair gender positioning of the woman in the sphere of domestic roles, even under the conditions where she contributes financially to running the family home. Furthermore, based on a study including 350 Roma women living in several isolated Roma settlements in Međimurje county, Croatia, Racz, Rončević and Milošević (2022)

proposed a model of prediction of exposure to violence against Roma women. Authors identified three predictive profiles of Roma women as victims of gender violence in Roma families considering that Roma women victims of childhood violence could have a much higher risk of being a victim of adult violence. On the other hand, in a report of United Nations (UNDP, 2018) it is also highlighted that Roma women in Albania, Montenegro and former Yugoslav Republic of Macedonia encountered strong intersectional inequalities based on gender violence against women as well as child and forced marriages.

Voicu and Popescu (2009) go deeper in this analysis, by suggesting that there are three determining factors that create the structure of gender relations: the educational level of the family members, the effective integration of both partners into the job market, and the influence of a community over the individual behaviour. Therefore, the sex-gender system prevails. Thus, it is considered that in families where the level of education is higher and there is a positive experience in the job market, the status of the woman is usually a better one, she displays greater involvement in making decisions in the household and a status closer to that of the man. Also, in modern families, where there is no longer a strict traditional control over family life, gender roles tend to be more relaxed than in traditional communities.

Interestingly, Mocanu (2008) highlights the fact that women belonging to the Roma ethnicity are more discriminated against than Romanian women, which shows that the former are subject to differential treatment based on their membership to the Roma ethnic group, than those belonging to the group of people with disabilities for instance, or poor people. The theory of absolute gender discrimination, supported by Băluță (2006), is based on the low degree of accessibility of women, which tends to zero in certain soco-ethnic structures. In the case of Roma women, the theory of intersectionality that points to the double discrimination suffered by women because of both their gender and their ethnicity, is confirmed.

In terms of gender relations exercised by public institutions on Roma women, Băluță (2006) highlights the fact that institutional gender discrimination is perceived as having twice the intensity/frequency for disadvantaged categories than for any other individual in Romania. Access to high-end job positions puts under the magnifying glass not only discrimination between women and men but also institutional sexism, the role of motherhood in the personal and professional development of women, and even the lack of social policies that regulate gender equality.

Spatial dynamics of ethnicities in post-communist Romania shows a decreasing trend of all ethnic groups except the Roma, whose trend is upward (Rotaru et al., 2023), who are prone to stigmatisation when migrating to different regions of Romania (O'Brien et al., 2022). Furthermore, in order to find better welfare, Roma migrated to western European countries (Pantea, 2012). On the other hand, most of the literature on the Roma people in CEE debates issues of marginalisation of Roma communities. Sadly, Roma people are usually perceived as outsiders, both at the rural (Creţan et al., 2023) and urban (Creţan et al., 2022) levels. Moreover, they are targeted by politicial leaders as an important electoral basin in order to gain votes (Doiciar & Creţan, 2021). The broader Roma Studies literature discussed also gender issues connected to the Roma women (Oprea, 2004; Pantea, 2012; Vrăbiescu, 2016; Vrăbiescu & Kalir, 2018), but none includes aspects of specific gender-based violence against the Roma women. In this respect, our paper brings theoretical contributions to the international literature on Roma women migrations, as well as on gender-based violence against the Roma women.

Study area and Methodology

Study area

This study is based on the analysis of the Eastern urban areas of Spain, where Roma migrant communities of Romanian nationality prevail. Comunidad Valenciana is a focal point of this area, and it is geographically comprised of Valencia, Castellón de la Plana and Alicante as its major cities. These cities and their surrounding towns (Villareal, Valldeuixo, Nules, Burriana, Xativa, Alzira, Alginet, Tavernes de la Valldigna, Gandia, Elche, Altea, Benidorm) and villages (Benisa, Alfas del Pi) have been populated by different ethnic minority groups in the last few decades. From a general perspective, Romanian nationals, including Roma people settled in Eastern Spain, migrated to this area mainly during the 1990s and 2000s. The majority of Roma migrants have chosen to work in Spain in construction, agriculture and tourism.

Methodology and data

This paper is based on a mixed-methods approach, including a survey carried out on 132 migrant Roma women and an in-depth, open-end interview with five Roma women living in the area of Comunidad Valenciana. Due to the lack of specific statistical Roma ethnic data that would have originated from the Data Protection Law, the two techniques have been beneficial in the achievement of our objectives.

The survey

The survey was designed and carried out to identify the impact of contemporary feminism on the reconstruction of gender identity of Roma immigrant women in the region of Valencia. The survey contains elements based on

gender characteristics in specific migratory communities, on gender equality in Romania as a society, and on the concept of social dignity. Significant factors that will be taken into consideration are the political involvement in social discrimination, the detection and analysis of domestic violence indicators and, nonetheless, the self-perceived identity of the Roma community.

From a geographical perspective, we are going to focus on the territory of the Spanish Valencian community, with a special emphasis on the Romanian female migrant Roma.

Demographic and social data is provided in Figure 1 below, which shows the approximate percentage of the interviewed migrant Roma females and their original place of departure to Spain:

As seen above, there is a moderate coverage of counties in Romania that our interviewees have come from, with Timis, Bihor and Mures being more prevalent. Given the Covid-19 regulations put in place by the Spanish government, physical contact with the subjects and their families has not always been possible; however, online contact was preferred instead and a large part of the participants have been fully cooperative throughout. The only setback that we have experienced was the withdrawal of some of the participants after being exposed to the sensitivity of the topic and having had to recall personal memories that produced visible pain and sadness.

The distribution and completion of the surveys took place from 27 July 2022, to 18 August 2022, in the Spanish territory of the Valencian Community (counties of Alicante, Valencia and Castellón de la Plana) (Figure 2).

The survey questions were in Romanian language and it was unnecessary to be translated into Romani language because all Roma women speak Romanian fluently. All Roma women gave full consent to respond to the survey and for the results to be published.

The methods of carrying out the surveys were both direct, i.e. face to face (precisely to avoid interpretation errors and preserve the accuracy of the information collected), as well as online, where computer-assisted means of communication were used (for instance, WhatsApp and emails). For the distribution of the online surveys, civil associations were contacted and agreed to cooperate; in particular, these were the Agency for Mediation, Integration and Social Cooperation, from the Valencian Community and the Foundation of the Spanish Gypsy Secretariat. Similarly, we were assisted by religious organisations (Orthodox, Pentecostal and Baptist churches) and private families, both in the Spanish territory, as well as in the Romanian one. Thus, from a procedural point of view, the survey application was made individually, in writing and/or online, orally, and physically and/or online.

The survey includes twenty-seven questions related to the investigation of the following objectives

- confirming the gender characteristics of the migratory space of departure.
- identifying the gender characteristics of the migratory space of arrival;

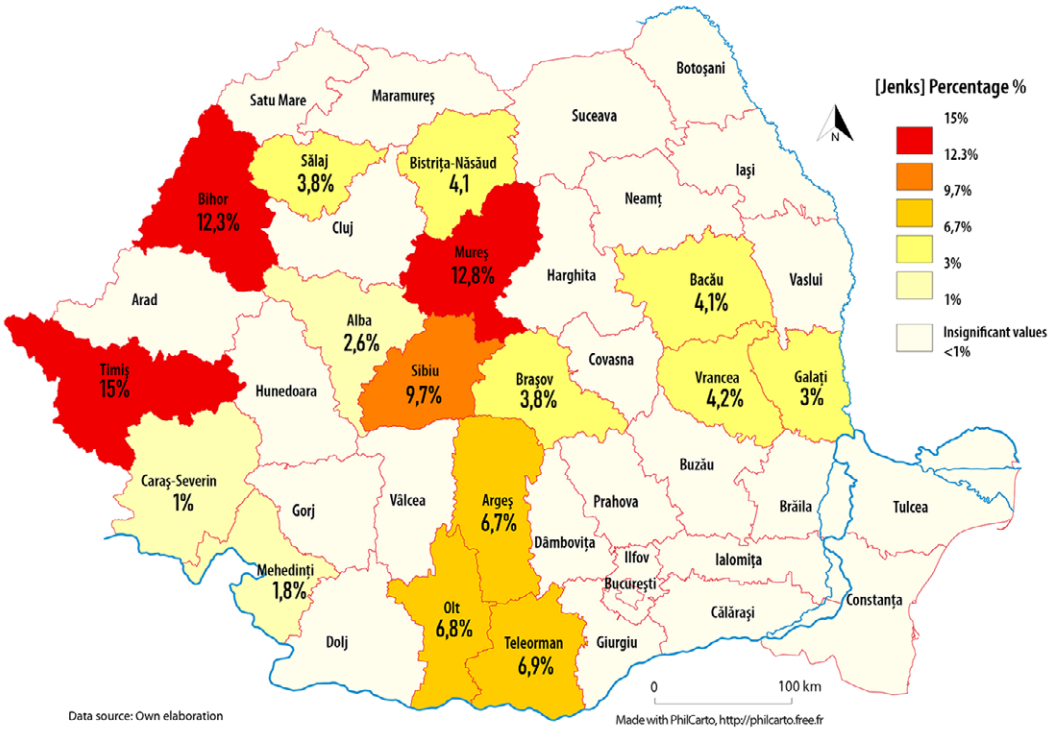

Figure 1. Romanian counties of origin of the surveyed Roma women

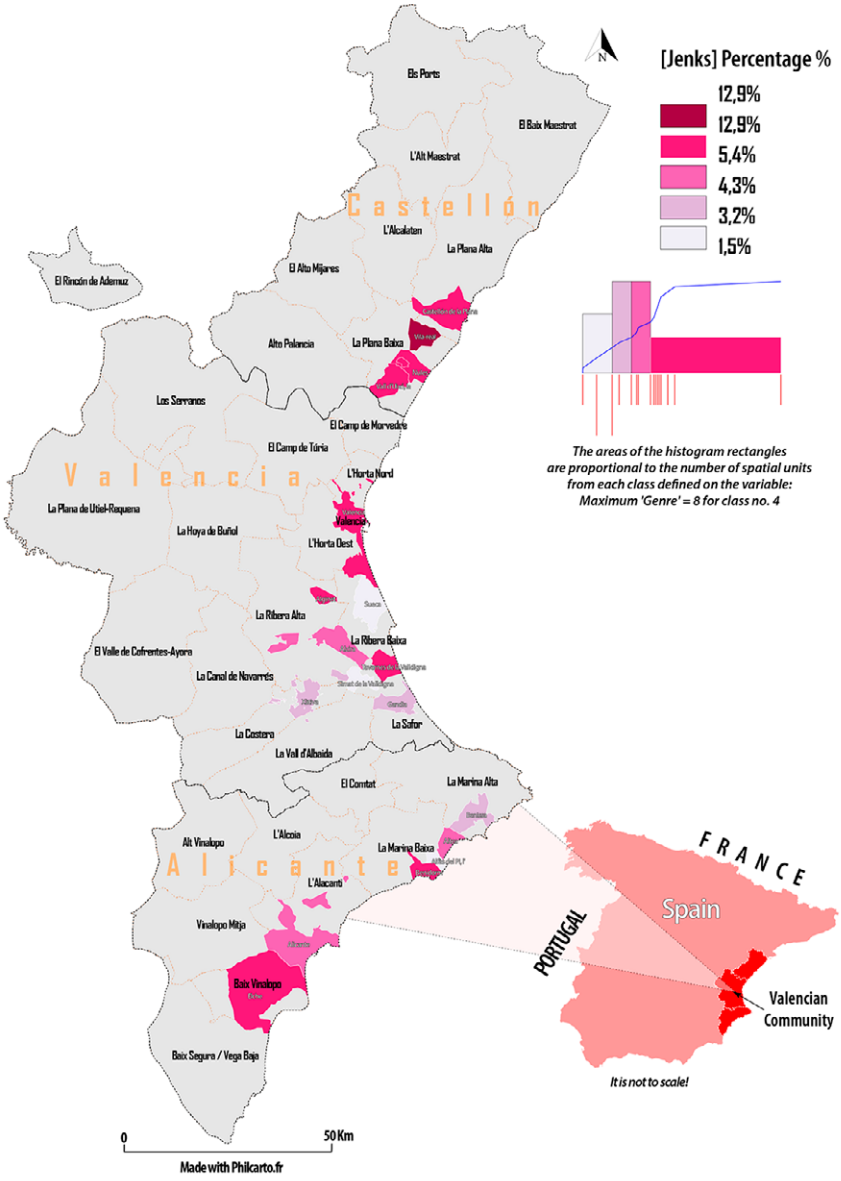

Figure 2. Study area - the proportion of surveyed Roma women in the total surveyed Roma people at the level of Valencian municipalities

- identifying equality between women and men;
- identifying social dignity and socialisation agents;
- reconsideration of political participation and nationality;
- detection and analysis of indicators of domestic violence (physical, economic, psychological, sexual in the migratory space of departure and arrival);
- analysis of gender equality policy indicators;
- identifying Roma contexts of gender power.

Semi-structured interviews

The first author of this paper approached five women to participate in the interview. Interviewees were selected from those who participated in the survey. The interviews took place online via the Google Meet platform in January-February 2023. The five Roma women gave full consent to respond to all interview questions but did not wish to be recorded, so the procedure of taking notes of all responses was used instead. The questions were about different forms of domestic violence that the Roma women encountered in Romania and in Spain. Questions were in Romanian language, as all respondents were fluent speakers of the target language.

The interviewees had an average age of 35 years of age. Four of them were minor when they left Romania (M.F. 15 years, I.L. 17 years, D.S. 13 years and L.P. 13 years). All the interviewees are nowadays mothers. From the point of view of marital status, only one person is married, two declared to be divorced, one is separated, and one is a widow (Table 1).

Table 1. Socio-demographic characteristics of participants in the interviews

Subjects' Initials	Residence in Spain Spania/ Valencia region	Settlement and county of origin in Romania	Migration year to Spain	Current age	Marital Status	Employment status
A.G.	Castellón de la Plana/ Region Castellon	Piatra Neamț/county Neamț	2006	52	Widow	Owns a bar / HORECA
M.F.	Alzira/ Region Valencia	Alexandria/ county Teleorman	2007	31	Divorced	Operator at an oranges' warehouse
I.L.	Valencia/ Region Valencia	Târgu Mureș/ county Mureș	2001	38	Separated	Chef at a hotel
D.S.	Alicante/ Region Alicante	Oradea/ county Bihor	2006	29	Divorced	Owns a bar/ HORECA
L.P.	Elche/ Region Alicante	Piatra Neamț/ county Neamț	2008	27	Married	Commercial agent at an international transport firm

Source: based on authors' own data interpretation gathered from the interviewees

It should also be noted that the average number of years since they settled in Spain is about 16 years, which also justifies the greater capacity of the interviewees' adaptation to the new lifestyle and standards imposed by the immigrant status. Therefore, the duration of continuous stay in the same economic-cultural space (Spain) is on average higher than that of the age of arrival in this country. This in turn can be an argument in favour of a form of cultural assimilation, with a tendency towards a new lifestyle based on respect for human rights and of the family, as can be seen from their responses.

From an employment point of view, it may be observed that two women own their own businesses in the HORECA field (hotels and restaurants), and three are also employed in the private field. One interviewee works in a company with international salience as a sales agent, which testifies to their professional competence, and the absence of discrimination in the work place.

All interview data was transcribed and a thematic interpretation was carried out. All the authors of this paper attentively read the transcripts and came across four themes of domestic violence that appeared prevalent in the data that was collected – physical and sexual violence, psychological violence, economic violence and verbal violence, which we present in the results section.

Results

Analysis of the survey

Regarding the age of the interviewees, we note the essential participation of people aged between 31 and 40 (35%) and those aged 41 – 50 (30%). At the other end we had three Roma ladies aged over 60.

We were able to observe that 16 Roma women claimed that they were divorced or separated, from which we could conclude that social and gender transformations of immigrant Roma women did occur. Traditional patterns of marital behaviour indicate an effective adaptation to the changes of current Spanish society, and the migrant Roma woman being more than able to demonstrate her capacity and zeal for personal transformation. (Table 2)

As for the province and localities in the Valencian Community where the people surveyed live today, the results show that most of them, i.e. a percentage of 37.1%, live in

Table 2. Socio-demographic characteristics of participants in the survey

Age	Marital status						Province of Residence in Spain			
	Married	Cohabiting	Divorced or separated	Widower	Single	Total	Castellón	Valencia	Alicante	Total
over 60s	-	-	-	3	-	3	-	2	1	3
51-60	8	-	-	3	-	11	5	2	4	11
41-50	21	8	11	2	-	42	17	14	11	42
31-40	28	16	5	1	-	50	17	17	16	50
19-30	3	20	-	-	3	26	10	9	7	26

Source: based on authors' own data interpretation gathered from the survey

the province of Castellón, a county with a high percentage of Romanian migrants. The Roma women surveyed live in the towns of Villareal (7.6%), Vall d'Uixó (5.3%), Nules (5.3%) and Castellón de la Plana (4.5%). In second place is the province of Valencia, where the cities where the interviewed Roma communities predominate are: Alginet (6.1%), Alzira (4.5%) and Valencia (4.5%). In the last category we note the province of Alicante, with 29.5% of the female Roma interviewees, residing in Elche (6.1%), Benidorm (5.3%), Altea (4.5%) and Alicante (3.8%).

Regarding the counties of departure from Romania, the respondents indicate, once again, Timiș county in the first place, with 16.7%, a result that can have a slightly subjective interpretation, due to the undersigned's pre-existing contacts and the increased interest in interviewing Roma women from the Banat region. The following county represented as the departure area is Mureș, with approximately 14.4% of respondents. At the opposite end we find the counties of Mehedinți, Alba and Vrancea, each having less than 0.4% of respondents.

An interesting factor in identifying the gender characteristics of the migratory space of departure, it could be remarked that 59.1% of the interviewees left their migratory destinies led by the father, the family's patriarch. In comparison, 39.4% of the interviewees accepted the husband's decision to emigrate to Spain. We note only two responses in which it is stated that the Roma woman was the one who decided to migrate to Spain, which defies the context of long-standing traditional Romani patriarchal supremacy in Romania. We also observe that, before the initiation of migration to Spain, there was a marital consensus between husband and wife in the proportion of 1.5%. Most of the responses come to reinforce a timid change in the decision-making tendency related to the migration process.

These comparative data presented in the table above come to strengthen the theory of Voicu & Popescu (2009), which approaches the issue of gender equality through the lens of influence that the social community has on the individual behaviour of Roma women in general, a fact that can also be applied specifically to migrant Roma women in Spain.

Interestingly, data shows that, in Romania, only 29.6% of Roma women declare they have not faced this situation. At the same time, the rest admit that they have suffered severe manifestations of domestic mistreatment rooted in financial reasons: 24.2% state that their husbands do not allow their wives to manage the family money and, furthermore, limit their access to money altogether. Curiously, 19.7% of interviewees accused their husbands of being squanderers, and 13.6% stated that their husbands left them with money to only meet the bare necessities of the family for a few days. Only 6.8% of the Roma women surveyed did not want to respond to this question. These data are noticeably different from their living situation in Spain, as 63.4% state that they have not identified with situations of this kind during their stay in Spain. In comparison, only 11.5% admit that their husband does not allow them to manage the family's financial resources, and 6.1% believe that their husbands left them strictly with the money needed for food since they had migrated to Spain.

Strangely enough, almost half of the subjects stated that domestic violence seemed to have become more frequent (48.5%) in Spain than in Romania (31.8%). This fact may also explain why some interviewees were reserved in making the answers of this study public in Romania. Moreover, a negative transformation of male domestic behaviour is evident throughout the migratory process, and even more so during the period of these families' residence and settlement in Spain.

Psychological violence further indicates a surprising balance of opinions because 32.80% of the interviewees admit that they have suffered this type of violence in Romania. Another 34.30% say that they do not identify with humiliating situations, with mean or humiliating jokes in public and at home. In Spain, however, as we can see in the graph below, the situation changes substantially - only 8.2% recognise this type of situation (all are women who live with their partner, without being officially married or declaring that they are divorced/ separated), and 40.3% state that they do not identify with this type of situation. However, we note the considerable decrease in the incidences of psychological domestic violence from 33.33% in the period lived in Romania to 8.3% in their period spent in Spain, due to the integration of Romania into the EU and the observation of the new rules of Spanish social life.

A staggering 21.1% of Roma women admit that in Romania they were subjected to jealousy from their husbands, having received verbal messages with sexual connotations, suffered sexual harassment, were even raped, etc. However, for the period spent in Spain, these forms of violence in Spain decreased to 7.8%.

Broadly speaking, following the analysis of domestic violence indicators, we can conclude that the majority of migrant Roma women (70.1%) have changed their social perception of equal rights between men and women, which fostered a stronger desire for them to become autonomous.

Analysis of the Interviews

Physical and sexual domestic violence

The results related to physical domestic violence identified in the answers given by the interviewees revealed that only A.G., who is also the oldest of the interviewed, who came to Spain married, was the victim of continuous violence from her husband, both in the home country and the host country. The subject admitted to this form of abuse as more prevalent after settling in the host country (Spain).

In regard to types of physical abuse, A.G. confirmed punching, pushing, adding that the frequency of these acts of aggression was unpredictable. This lady labels a specific set of acts of violence as "severe", namely, the times when they were conducted in front of children. Inevitably and unfortunately, the constant (or even one-time) exposure of children to domestic abuse in their own home has a domino effect, which forces them to endure the ruthless humiliation of one of their parents, where the perpetrator is the other parents. It does have a long-standing shock effect on both the children and their mother, as they will be unwillingly exposed to long term insecurities, trauma and broken identity, among others. Thus, it is safe to say that physical abuse goes hand in hand with psychological abuse and probably, only specialised support may enable the victims to find complete healing and make a fresh start. Fortunately, laws against domestic violence are robust enough in Spain to prevent a family from going through this trauma; however, fear of further, harsher forms of abuse from their husbands prevent these women from seeking help and reporting the perpetrator.

Moving on, the other four women interviewed were not married in Romania. However, they noticed this „habit" of beatings and other forms of aggression in families of provenance, parents and grandparents, and neighbours of the same ethnicity. Our previously mentioned A.G. emphasises the authoritarian role of the man, leader of the clan/family, including physical violence against the wife, a traditional inherited role from father to son. As for the physical consequences - wounds, contusions, fractures, the skin tears etc., -2 answers attest to the presence of women in the family who act as 'doctors', respectively their mothers. If family members are unable to help the victim heal, specialised help is finally sought from medical staff in a hospital. This in turn shows the degree of vulnerability and helplessness of women who fall victims to their own partners.

A different point of view is offered by L.P., who talked more about her father, to whom she attributes a „more authoritative" attitude after arriving in Spain. However, some responses given by the interviewees show their tendency towards taking a stand and acting accordingly, or reacting to physical abuse from their own family, by calling the authorities, especially the police. This shows a positive shift in traditional tendencies within the Roma family unit, with women now actively exercising their rights, and recognising their abilities (to run a home, to be financially independent, etc.), although much more work needs to be done in this field in order to see long term results.

Furthermore, the characteristics of more respondents' declarations, especially those given by D.S. or L.P., represent the first steps towards the emancipation of Roma women. At the base of these female reactions are the conscious rejection of abusive practices and the confrontation of the „adversary", who fosters convenient conservatism. Therefore, we have sufficient evidence to believe that there was significant data available to the authorities that enabled the creation of a rigorous set of laws that tackle domestic violence. In fact, Torres Falcón (2004) remark that domestic violence that occurs in the private space must be the responsibility of the State, which must include sanctioning abusive conduct (whether by administrative, civil or criminal means), as well as the establishment of protective measures that would guarantee freedom and safety for the victims. Based on the International Law of the U.N. Declaration on the Elimination of Violence against Women (1993), Spain produced the first comprehensive Pact against Gender Violence in January 2004 (i.e., Law 1/2004, that was approved in December 2004. The State Pact against gender violence was approved in 2017). Similarly, an additional law was released in 2007 that would further challenge inequalities, called the Law 4/2007 on effective equality between women and men. The rule of inverse proportionality has begun to be phased out in countries such as Spain by implementing women's inclusion policies and gender equality plans reflected in the Organic Law No. 3 of 22 March 2007 and Organic Law of October 2022. Both laws are important because they favoured to the implementation of public policies that promoted equality and consequently gender identity in Spain. Also, the Valencian Community has laws against gender violence and equality between women and men.

The Organic Law 10/2022 is based on the comprehensive guarantee of sexual freedom.This allows us to compare the two styles of coexistence: first, in the country of origin, with more lax legislation, and second, in the new host country, Spain, where the rule of law is based on interculturalism, respect and robust social protection. It is also vital for migrants of all kinds to succeed in their integration process as a group, a family, or an individual, and achieve their goals.

In Romania, the first step in legislation against domestic violence was the Organic Law No.217 of May 2003 and, most recently, the Organic Law No. 183 of 2022. All these laws clearly emphasize the importance of gender equality and equal rights for women.

The continued reactions of violence against women in the family determined either by grandparents' family model, by jealousy or by refraining women from financial autonomy, have led some of our respondents to seek help, with two of them filing official complaints with the Spanish authorities, and one that has chosen to take the route of reconciliation with her partner. Exceptions are A.G., a follower of a conservatism, and M.F., who is afraid to make an official complaint, admitting to being apprehensive of public rejection from her clan.

Finally, only one woman had not gone further with her intention to file a written complaint against her husband, as a result of being pressured by her elder children who were afraid of having their father thrown into prison and consequently become the laughingstock of the Roma community. Public shame has always been a strong deterrent against the challenges of domestic violence, bringing 'tradition' forward as a priority over family peace and over mutual respect, which leaves most women fighting a lonely, seemingly helpless battle.

Domestic sexual violence on the other hand, is one of the most reprehensible forms of domestic violence. Given the deep traumas it causes the victims in the long term, this form of violence also exposes the flagrant violation of basic morality and calls urgently for the intervention of the community and the action of the authorities. In Northern Ireland for instance, the Department of Health and the Department of Justice (UK, 2019) worked together and implemented a new set of laws that aimed at offering continuous support to victims of domestic sexual abuse. In their seven-year support plan, the authorities tackle the effects of this type of violence on the victims, grant psychological and financial assistance, and even offer guidelines to employers, whilst perpetrators are brought to justice.

Evidently, criminalizing domestic and sexual violence is the first step forward. Making the victims aware that they are being abused is a milestone in itself, and ensuring that they are fully informed of the support that is available to them is another. Their own psychological barriers might be the reason why they never ask for help, which fosters the perception in their partners that they can continue abusing their wives, and precipitates these victims into becoming the 'hidden faces' of modern-day society. Not surprisingly, their own children who have been exposed to this family model, will probably create their own families and run them in a similar manner, which creates an endless cycle of perpetual abuse.

It also follows that jealousy is a determining factor in a potential family conflict (jealousy can also derive, beyond feelings exacerbated by affection, from the man's need for control and the unconditional maintenance of the woman's subservience). At the same time, the idea of sexual abuse between the two spouses is excluded from the point of view of the same A.G., who considers that, after marriage, the woman belongs to the man, therefore excusing her husband's behaviour, and posing no conditions to marital cohabitation. Basically, once married, there is no concept of 'rape', as sexual intercourse is understood as 'part of marriage' regardless of both spouses not being always prepared for it (due to health conditions or mental health).

From the responses received, it also emerges that these forms of sexual violence were not perceived as a form of abuse by the interviewees, as A.G, herself explains that 'religious morality' does not include the concept of 'rape' in a marriage. Moreover, I.L. also admits that she did not know that the phenomenon of violence existed in sexual intercourse in married couples, which indicates a poor level of information, and insufficient education in this regard. Sadly, this is a commonly held mentality in Romanian society - but also, possibly, these customs are ethnically inherited from a generation to another in set groups, such as the Roma in our case. These women were raised by their mothers since they were little girls to blindly accept abuse, blaming religion and tradition for this 'metamorphosed' morality.

Once these families had arrived in Spain, it was noted in the interviews that compliance with the ethnic-specific family code was maintained as a paramount priority, whereby the wife must respect her husband unconditionally. Four out of five interviewees married during their stay in Spain. Out of these, two confirmed cases of jealousy from their partners, three confirmed sexual intercourse under the influence of alcohol, one revealed sexual indifference, and one sustained her affection towards the ex-husband decreased in the meantime.

As forms of reaction, most of the interviewees declared themselves dissatisfied with their sexual life after their arrival in Spain. This feeling had appeared either sometime after the early stages of marriage, or after they had had children, or even after the extramarital experiences of the husband. One stated the normality of sexual life in the couple, which was still stained by the husband's jealousy.

Psychological domestic violence

Psychological violence is a filtered form of gender-based violence. Psychological violence and control are traumatic in the long term, with side effects that can last a lifetime: lack of self-confidence, distrust of others, nervous exhaustion, depression etc. It could be expressed through a gesture, a word, comparing one's spouse to another, or humiliating them by pointing out what one perceives as physical defects. These forms of aggression naturally lead the victims to see themselves as unattractive and insufficient, lowering their self-esteem and weaking their defense mechanism when feeling attacked. Psychological violence is very likely to have destructive effects on a massive scale, which can destabilize a whole family and destroy its unity at the core.

For the period lived in Romania, the cause of domestic violence identified in the present interview is one's family status, in which the woman/the wife is always in second place, a fact demonstrated by continuous verbal humiliation, as A.G. admits. Pressures from the side of her husband's family puts the victim into isolation. Furthermore, a paternal dictatorial attitude was also reported by D.S., who defined the role of a man in the Roma family and set the scene for D.S.'s role as a future wife and a mother, where she had already perceived the male figure as a tyrant. The other respondents revealed the obligation to respect the unwritten laws of ethnicity, the total submission to the husband, and the public humiliation of the wife. The prohibition to call for medical assistance was identified by all Roma respondents.

For the period lived in Spain, the causes of continuation or the manifestation of psychological domestic violence and control identified in the interview are language barriers - because the Roma language was not understood in the community, the attitude of superiority on the part of the husband (knowledge, intellectual capacity), and imitation of one's paternal model as a male figure in the family. As if these were not enough, our participants also cite indecent behaviour of the husband in public as a form of humiliation, envy of his wife's professional achievements where the situation is given, and lack of appreciation of the wife's full commitment to domestic tasks.

Among the effects of these psychological traumas are: divorce, fear of the unknown, insomnia, loss of appetite, effects on physical health (e.g. cessation of lactation), and self-hatred. However, Roma women's devotion to their families and especially to their children, have given them the motivation to move forward: they felt a stronger will to look for a job, to attend courses that prepare them professionally, and to look after themselves as women. Our subjects' exposure to more emancipated women in the Spanish society has showed them a different way of life, and that transformation is possible. Some forms of support that our respondents benefited from that have enabled them to make significant changes were counselling from a psychologist, their general practitioner, their mother and some friends.

Economic domestic violence

What we call *economic domestic violence* can be summed up in money control. Through money, the husband - the head of the family - can control the domestic micro-universe, both from a material point of view, and a psychological point of view, by creating dependence of his family on him. Once this dependence is created in one direction, husband towards wife, male dominance is established within the family and, naturally, the wife's submission follows. If the woman is not able to overcome this status, there is a risk of family imbalance ensued by constant arguments.

As for money expenditures in the families of the interviewees, wives were given just enough money to buy food when living back in Romania. Recurrent issues arose when the wife complained of insufficient money to meet the family's needs, which led to accusations from the husband that his wife is unable to manage the (little) money she is given efficiently. This in turn led to strife and, eventually, to physical violence.

In Spain, some Romanian Roma families have succeeded to achieve their goals: a better life, a better and more secure future for their children, earning higher salaries to help their relatives back home, or for future projects. If they felt it was necessary, our subjects asked for help from institutions like the town hall, the Red Cross and Cáritas. When the family unit found temporary work in agriculture, the Roma woman was willing to emigrate to work together with the family in other parts of Spain, or even in the other EU countries.

This demonstrates the change in attitude towards incorporating women into the job market, giving Roma women a chance for economic independence. It begins to dissolve barriers of seclusion, resets gender mentality, changes the public perception of the gypsy woman's role in family life and includes her in decision-making, money spending, and inclusion in the community.

This financial independence, due to some advantageous jobs, or some investments in their own businesses, was managed in expenses for child support (quality food and clothing), home maintenance, personal care and education, as well as real estate investments. In this context, Roma women have proven an outstanding spirit of entrepreneurship. However, the dependence on the material resources provided is discretionary to their husbands. Moreover, the idea of affirmation and success no longer exists as a privileged prerogative of only some Roma women, but it is now a result of their own will at a larger scale.

Verbal domestic violence

Verbal violence is one of human nature's most pervasive forms of aggression. It carries meaning and includes harsh messages. When we choose a set of words that we accompany with certain inflections of our voice and use a specific face expression, we communicate our thoughts. What we communicate is just as important as how we communicate it. Verbal domestic violence, just like physical violence, represents a form of domination, intimidation, and humiliation.

Based chiefly on verbs, adjectives, interjections, and other forms of expression, verbal violence is the index of a permanent power imbalance between *me* and *you*, between a perpetrator and a victim. The use of abusive language could go from a „canonical" insult to the vulgar one, which in turn could either be grotesque or rough.

Verbal violence is also pervasive, as we have seen, in all environments, from the street of our town to TV shows. In

the family, verbal violence can sometimes be a prelude to physical violence as one of our interviewees stated:

A.G.: *He swore at me every day, it was something normal... My goodness... I promise, it was a daily habit for him! However, I got used to it... He did it both in the house and on the street!... Clearly, he was doing it as something normal!*

In the migratory space of origin, experiences of verbal violence from the husband were prevalent, the only one who communicated this experience was A.G., married in Romania. The place of manifestation of domestic violence is either at home or in public space, without any shame. This interviewee presents an interesting picture of adaptation to the daily maltreatment from her husband, fully aware that this is a model of behaviour in the Roma community. The unconscious repetition of "normal" is key, as the victim has never been able to see that behaviour as normal, but is visibly shocked that her husband has gone forward and made it a "habit".

All five interviewed women recognised the practice of swearing in the family as something prevalent. Four of the subjects explained that verbal violence is a common form of expression in Roma families, from neighbors to friends who pay them a visit. The existence of this practice was also given when the father of D.S. swore when „he was drunk," or disapproved of her mother. In the case of I.L., she manifested the lack of confidence in the probability of a positive change in her husband, at least in the short term, once arrived in Spain.

Regarding the involvement of the authorities (i.e., the police), the responses are similar to those regarding physical violence. These women are too afraid to ask for help, which portrays an ironic distrust in the public authorities, but could also suggest that having asked for help back home in Romania, they did not get the support that they needed, which placed them at a higher risk. This may have created a precedent for future decisions of this sort, which explains the Roma women's fears.

In terms of continuing verbal violence, all five interviewees declared that nothing had changed in their husbands' behaviour after they had moved to Spain. Apart from A.G., the other four ladies interviewed have married in Spain. However, their spouses' verbal abuse had already been assimilated by them and used in the country of origin, even by M.F.'s husband, who is of Romanian nationality but not of Roma ethnicity.

The responses of the interviewees confirmed that the new lifestyle, in a new geo-cultural area, the impact of a new civilisation, and the accountability demanded by a new set of laws, had no impact on their husbands, who did not change their behaviour or language. A nuanced response is formulated by L.P., who considers her husband's verbal aggressions as an expression of envy felt by him for his wife's personal successes, but also his unfulfilled desire to get her to stop working, stay at home with the child and depend on him.

It should also be mentioned that a Roma woman challenging her husband's abusive behaviour may pose an atypical attitude from a traditional perspective, which may cause the perpetrator to increase their level of aggressiveness and fear-control their victim. The reactions that some of our interviewees had in their attempt to refute their partners' conduct is admirable, as it brings about a much-needed change in the family, and a hope for future generations. The emancipation of Roma women is a step forward, and indeed the support of Spanish authorities when called for, has left its mark.

To sum up the comparative results from the survey and interviews (Table 3), the conclusions clearly indicate the same tendency of transformation of the gender mentality of immigrant Roma women:

Table 3. Comparative results of the survey and the semi-structured interviews

The survey	Semi-structured interviews
▸ gender roles tend to be more relaxed and egalitarian in Spain than in Romania; ▸ the traditional patriarchal dominance in decision-making in personal and family life is diminished in Spain; ▸ a new behavioural trend is observed for the Roma migrant women during their life experience in Spain; ▸ awareness of the social importance of women in the social sphere is becoming more prevalent in Spain than in Romania; ▸ personal and social emancipation confers with Roma women the figure of the integrating social agent in a new host society.	▸ the reduction of physical domestic violence is the result of the positive pressure from the host society on the Roma individual obliged to respect the new rules of coexistence; ▸ sexual domestic violence undergoes an experiment of slight improvement in individual male behavior Roma between the period of living in Romania and Spain; ▸ the decline in economic domestic violence is based on the incorporation of migrant Roma women into the Spanish labour market; ▸ the reduction of verbal domestic violence indicates new Roma masculinities more respectful of the couple; ▸ the decrease in psychological domestic violence reflects the influence exerted by the Spanish social environment on marriage as a whole, and on the Roma woman as an individual.

Analysis of indicators of domestic violence (physical, sexual, economic, psychological, verbal) presents several patterns for Roma women (Table 4).

Table 4. Comparative degrees of domestic violence perceived by the interviewed Roma women

Type of violence	Experience impact in Romania	Experience impact in Spain
Physical	High	Low
Sexual	Moderate	Low
Economical	High	Low
Psychological	High	Moderate
Verbal	High	Moderate

Firstly, physical domestic violence registers increasingly reduced values on Spanish territory due to the implementation of social protection measures, the awareness of the problem, and the education Spanish society gives to the present generation. Gender roles tend to be more relaxed and egalitarian compared to traditional Romanian society.

Secondly, sexual domestic violence shows significantly lower values in the new migratory space compared to the Romanian geographic space, due to the influence of the social community on the individual Roma male behaviour, a fact that can also be extended to the Roma female migrant in Spain.

Thirdly, economic domestic violence has a lower value in Spain than in Romania due to the incorporation of Roma women into the Spanish workforce. This chance has given them economic independence, which in turn generated personal and family economic comfort.

Next, psychological violence experiences a considerable decrease in incidences, given the influence of the social environment on marriage, integration and compliance with the new rules of Spanish social life.

Finally, verbal domestic violence has not decreased too much once the family had reached Valencia as compared to their time in Romania. As such, modifying masculinity along the migratory process is possible, in favour of a new gender identity that is more respected and valued.

Discussion

In the literature on peripheral feminism, the issue of domestic violence against Roma immigrants is practically unaddressed. Having as a starting point major debates on domestic violence (Cantera, 2005; Cantera, 2007; Dutton & Golant, 1997; Ferrer Pérez & Bosch Fiol, 2005; Heise, 1998; Mullender, 2000; Perrone & Nannini, 1995; Ramirez, 2000; Soler, Vinayak & Quadagno, 2000; Walker, 2004), we identifieded a series of changes in social behaviour and gender of migrant women of Roma ethnicity.

In the new Valencian space of migratory destination, gender roles tend to be more relaxed and egalitarian, a fact that contradicts the theory of Perrone & Nannini (1995) that relates the behaviour of the aggressor with the inability to modify and adapt the way of thinking and acting of men in the domestic sphere, under the umbrella of a society marked by profound changes in social optics and feminist values. Roma migrant women demonstrate a much more visible shift in gender mindset than Roma men.

The awareness of the social importance of women in the social sphere becomes more present due to personal empowerment, integration, and a certain acculturation to which the new host society invites. Consequently, verbal, psychological, and economic domestic violence, explained by Gelles (1974), is diminished by reduced stress in the couple's relationship and confers a personal and social emancipation never seen before in the Romanian country of migratory departure.

It has been shown that domestic violence, as indicated by Cantera (2007) as a political, public, social and moral problem, is deeply rooted within the Romanian immigrant Roma ethnic group, where the traditional patriarchal model predominates, above all. However, the new imbalance of power manifested by the partners/families of the interviewees put the focus of the analysis on the emergence of a new mentality in the Roma woman based on the following issues:

- reducing the phenomenon of physical domestic violence. Based on the desire to constantly express the domination of the patriarchal family model and the exploitation of female vulnerability (Heise, 1998) and apparently without resolution in the migratory space of Romanian origin, physical and sexual domestic violence began to be seen as abuse and confronted, steadily, by some of the Roma women interviewed, especially young women in the migratory space of Valencian destination.
- awareness of verbal domestic violence. Despite the generational inheritance received analysed by Dutton & Golant (1997) and the real and timely support received from the Spanish authorities, we identified the increase in verbal domestic violence due to the imbalance of power in the couple's relationship and the timid desire for emancipation of Roma immigrant women.
- the economic emancipation of migrant Roma women. This aspect reveals the commitment to reducing the feminisation of poverty among ethnic Roma immigrants. This process leads to the incorporation of Roma immigrant women into the Spanish labour market.

Roma immigrant women have proven to be able to remove obstacles in their career paths and reduce difficulties in reconciling family life with work. Nevertheless, despite several laws supporting the equal inclusion of women in political, social, and economic leadership positions in society, immigrant women Roma is far from being socially included in Spanish society.

However, traditional patterns anchored in Roma patriarchy have still been detected in aspects of sexual domestic violence and verbal violence. Sexual domestic violence, a taboo subject within the Roma ethnic group, remains challenging to investigate. The interviewees' negative responses and conservative attitude, above the jealousy and exacerbated feelings of affection for their partners/husbands, demonstrate unconditional respect for the family. In general, it can be said that domestic sexual violence does not have significant differences between the two migratory geographical spaces, being that the unwritten rules of intimate life are practically the same. Furthermore, no extreme practices of sexual violence (prostitution, human trafficking) have been identified. On the other hand, verbal domestic violence means controlling the victim and/or creating fear to dominate the victim (see Alcañiz, 2015; Ferrer Pérez & Bosch Fiol, 2005). It is presented as trapped within the comfortable limits of ethnic heritage not altered by migratory processes. The idea of the impact of a new society and the social responsibility within it must have a substantial impact on both spouses and is invalidated since the Roma spouses did not improve their behaviour or verbal language in the domestic sphere.

Conclusions

Roma people who chose to migrate from Eastern Europe to Western countries for better welfare have shown that Roma people and Roma women, in general, are prone to stigmatisation even in Western societies (Creţan et al., 2022; Vrăbiescu & Kalir, 2018). Their adaptation to the new migration space encountered many obstacles already debated in the existing literature (Pantea, 2012). However, the issues of how Roma women became emancipated in Western Europe, and how they faced domestic violence are a less-researched topic.

Our findings reveal that regarding the confirmation of the gender characteristics of the Romanian migratory space of departure, the predominance of the traditional patriarchal supremacy of the Roma ethnic group can be observed, both from a decision-making point of view and from the point of view of the distribution of domestic attributions between life partners. Instead, in the new Valencian migratory space of arrival, the gender characteristics are changing, giving more value to the Roma woman in terms of the fair distribution of domestic tasks, and decision-making in the family. Among migrant Roma women, their ability to adapt to new possibilities for professional development outside their home, whilst coping with domestic duties is outstanding. Therefore, the creation of new levels in the structure of gender relations is demonstrated, reflecting the creation of new gender identities for the Roma migrant woman.

The majority of Roma women have changed their social perception of equal rights between men and women. Thus, their definition of equality between genders changed, especially after they had lived in Spain and were exposed to a new lifestyle and set of ideas. Despite the lack of feminist social culture back home in Romania, and despite their traditional ethnic ideas, some of our Roma female participants were able to transcend these mindsets and make a substantial change in their lives. It should also be noted that the set of laws that tackle domestic violence is more robust in Spain than in Romania, although both countries have still got work to do in confronting this issue at the core.

On the one hand, we may also observe the role of Roma women as the primary social agent in the process of integration and adaptation to the new Spanish society and, on the other hand, its evolution in the process of social transformation and personal development. Once again, the impact of Spanish feminism in the reconstruction of the gender identity of the Roma migrant woman is validated.

Our findings call for the necessity to implement effective laws that protect the rights of women and guarantee equal opportunities for men and women. Moreover, there is a need to implement national and local plans of action that protect victims' rights. Providing better education, equal treatment, and free specialised services for abused women would be a step forward. Moreover, increasing the number of Roma women in the police forces are seemingly ambitious plans that could be fulfilled in the future.

One of the limitations of this study was that we were only able to tackle a relatively small group of Roma women who migrated to Spain. Another limitation is that we did not include the opinion of the Roma men. Future studies can be made in other Western migratory spaces where the Roma women live to find out if the Roma women encounter similar patterns. Moreover, comparing Roma women to other migrant women would be an interesting point of study for another research paper.

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Governing Geospatial Aspects of Smart Destination Development – The Case of Novi Sad, Serbia

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ABSTRACT

The development of smart cities and destinations heavily relies on geospatial technologies and intelligence. Geospatial aspects encompass location-based data and tools and are of significant importance in governing smart tourism destinations. This paper investigates the geospatial elements involved in the development of smart tourism destinations, by analyzing smart projects implemented in Novi Sad, Serbia. The theoretical framework draws upon the fields of geoinformatics, urban planning, and smart city development. Research conducted in Novi Sad reveals that the majority of smart initiatives, solutions, projects, and practices are geospatially oriented. To enhance the governing of smart cities, the paper introduces a comprehensive and adaptable catalogue of smart projects, which is easily navigable and comprehensible.

Introduction

Smart destination development involves using technology and data to improve the sustainability, efficiency, and overall quality of tourism destinations (Cimbaljević et al., 2019; Gretzel & Stankov, 2021). Geospatial aspects refer to the location-based data and tools that can be used to inform and guide this development. Governing geospatial aspects of smart destination development refers to the policies, strategies, and decision-making processes that are used to guide the use of geospatial data and tools in the development of tourism destinations. This can include the development of regulations and standards for the collection and use of geospatial data, the establishment of public-private partnerships to support the implementation of smart destination initiatives, and the creation of governance structures to ensure that geospatial data is used ethically and responsibly. (Radojević et al., 2020). Some specific examples of how geospatial data can be used in smart destination development include using location-based data to optimize transportation systems and reduce congestion in popular tourist areas, mapping tourist flows to identify areas of high and low traffic and to better understand visitor behaviour, using geospatial analysis to identify areas of natural or cultural significance that should be protected from over-tourism or development and creating virtual maps and immersive experiences to help visitors navigate and explore a destination. Overall, the governing of geospatial aspects of smart destination development is an important consideration for destination managers and policymakers who want to leverage technology and data to create sustainable, resilient, and attractive tourism destinations.

This research harbors multiple objectives. First and foremost, it aims to construct a comprehensive catalog of smart initiatives in Novi Sad, categorizing them for facile

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analysis and practical application. The study encompasses an overview of smart projects, their organization, the identification of key participants, and the most frequently employed geospatial technologies. Additionally, the researchers aim to demonstrate the prevalence of smart, geospatially oriented projects that collect, process, and display data with geospatial and temporal references. Organizing a catalogue of geospatially oriented smart projects for smart tourism destinations requires a focus on location-based data and tools, as well as an understanding of the specific needs and goals of the users who will be accessing the catalogue. The case study in Novi Sad forms an extensive catalogue of smart projects, and based on the analysis of geospatial aspects, conclusions are drawn, proposals for implementation are given, and guidelines for future research are derived.

Theoretical background

The theoretical background of the geospatial aspect of governing smart destinations draws from a range of fields (Vujičić et al., 2020), including geoinformatics, urban planning, and smart city development, starting from the assumption that for smart tourism destinations and smart cities geospatial aspects, technologies, and geospatial concepts, especially positioning, geographic information systems, and geospatial data infrastructure, are an indispensable framework and that they play a very important role in the construction, use, and management of smart destinations and smart places in general (Li et al., 2013). Geospatial information sciences play a key role in providing the basis of the theoretical framework and practical actions for the collection, processing, analysis, and presentation of data (Gruen, 2013). On the other hand, theorists of geospatial sciences (Gruen, 2013; Roche, 2014; Tao, 2013) claim that smart destinations must be geospatially enabled, open and accessible, and possess geospatial intelligence to create a geospatially aware and intelligent society, most often urban, so they provide a theoretical framework in their research and provide a series of practical procedures for building smart destinations, based on the mass use and ubiquity of ICT technologies and the collection, processing, analysis and transformation and use of huge amounts of data everywhere and at all times.

Geospatial aspect of smart destinations

Geospatial technologies assume a pivotal role within the realm of smart destinations and cities, encompassing a diverse array of roles. They proficiently gather and amalgamate georeferenced data sourced from satellites, sensors, and devices, culminating in the creation of digital maps while furnishing predictive instruments indispensable for the strategic blueprinting of a sustainable smart urban milieu (Mete, 2023). This orchestration is further enriched by the utilization of Geographic Information Systems (GIS), allowing for the multi-layered analysis of data and thereby facilitating judicious resource allocation and informed urban design decisions (Liu et al., 2023; Mortaheb & Jankowski, 2023). Through the synchronization of temporal referencing and real-time monitoring via sensors and GPS, these technologies not only expedite responses to emergent situations but also engender an elevated urban quality of life. Moreover, the strategic deployment of these technologies fosters a heightened level of citizen involvement, exemplified through interactive maps and applications that cultivate collaboration within the urban planning domain. In the context of smart destinations, these geospatial tools extend their influence to augmenting tourist experiences in terms of smart navigation, location-based recommendations, virtual and augmented reality tours, real-time event and crowd management, smart transportation, emergency management, sustainable development planning and tourist analytics and promotion (Cimbaljević et al., 2023; Yang et al., 2023). There is a parallel between smart cities and smart tourism destinations because a large number of researchers believe that smart tourism destinations are created as a consequence of the implementation of smart city dimensions at the destination (Buhalis & Amaranggana, 2013; 2015). As cities are geospatial entities, geography in general, and geospatial technologies in particular, play a major role in enabling the concept of a smart city. (Percivall et al., 2015). A smart city has various properties from a geospatial point of view, which includes seamless integration with digital cities, sensor networks, and self-networking and self-maintenance capabilities. However, digital cities, smart cities, and smart tourism destinations are not separate but can be seen as integrated and merged as one entity that could be called a smart location or smart place (Li et al., 2013). Gruen (Gruen, 2013) points out that if we understand geomatics as the science of collecting, modelling, analyzing, and presenting geospatially referenced data, it integrates geodesy, geodetic measurement, photogrammetry and remote sensing, cartography, and geoinformatics as key disciplines. Williamson (Williamson et al., 2010) responds to this point of view with the thesis that throughout history

geospatial information was mostly an exclusive technology for surveyors, cartographers, and later GIS professionals. Today, geospatial information is increasingly being used ubiquitously and transparently by governments and the wider society in most activities and business processes (Kranjac et al., 2019; Marković et al., 2013). Applications in tourism, especially at the destination, can be just the icing on the cake of the use and influence of geospatial information and the global transformation of paper maps into the digital world. Similar experiences are pouring in from countries around the world where governments, economies, and wider society are becoming geospatially enabled. Geospatial information and geospatial technologies are very important for providing a technological platform that forms the backbone of smart cities and smart tourism destinations (Gruen, 2013).

Li and associates (Li et al., 2013) consider geospatial technologies as auxiliary techniques in the construction of smart cities. He states that the smart city (smart place) model is based on 2D (two dimensions) digital maps and 3D digital city models, 4D geospatial-temporal databases, and points of interest (Li & Shao, 2009). Positioning and guidance are of irreplaceable importance for all smart places, smart tourism destinations, and smart cities, because they involve locating and tracking.

He sees positioning and navigation primarily through GPS technology, and sees it as sensory, as data acquisition devices that can be an integral part of the Internet of Things. Li (Li et al., 2013) points out that based on the integrated positioning of the global positioning system, accurate information about environmental locations can be obtained for analysis for further environmental preservation. Location and navigation are among the first functions where GPS helps urban dwellers and visitors to get the right directions (Tao, 2013). Indoor positioning system (IPS) and navigation based on it have a significant application in tourism in spaces such as museums, galleries, etc. Indoor positioning is also considered to be important for tourism and Li (Li et al., 2013) lists the main methods that can be used for indoor positioning. Tourist movement networks through the creation of a virtual model can be very useful for the management of the tourist destination and as an aid in the promotion of new products and services to tourists following their affinities and wishes. By analyzing the model, the manifestation of the movement of tourists can be seen. Conclusions of this type are particularly adequate for big data that can be passively generated by smartphones by tourists within a smart destination. Also, it is possible to include spatial and temporal determinants for data as well as tourist experience in movement patterns (Baggio & Scaglione, 2017). Integrating video with GIS can be a very useful technology. In traditional urban systems, the content of video surveillance footage is displayed on multiple screens, and operators visually identify people for whom there is some kind of suspicion. This way of functioning, of course, cannot predict criminal events, and the processing of a large number of video archives significantly slows down investigative activities. Smart places alternatively offer more efficient data collection from video material. It is possible to effectively spot objects, identify and track people, analyze flows, and recognize individual movements and gestures, all in the fight against crime (Li et al., 2013). Street images, such as Google StreetView, have gained immense popularity as they are used in the model generation process. Images generated by highly professional mapping systems on mobile devices or by tourists or residents are now available to millions of people online. However, the accuracy and completeness of the results are still problematic, which should be the subject of further research (Gruen, 2013). Drone footage has been getting a lot of attention lately. A large amount of visually appealing footage of various locations has been created, but there are still problems affecting their production and their significance. When creating these recordings, they have the possibility of temporal and geospatial referencing, so further development of this geospatial technology can be expected in the future (Stankov et al., 2019).

Remote sensors and smart infrastructure can generate large amounts of data that need to be processed and analyzed to be useful for tourists. Geospatial, temporal, and contextual information are critical components of this analysis, as they help to provide location-based and time-based context to the data. This contextual information can help to improve the relevance and accuracy of the data, making it more useful for tourists who are seeking specific information or experiences. In addition, data processing and analysis can help to identify patterns and trends in the data, which can inform destination management and policy-making decisions (Radojević et al., 2020). Tourists need to assess the effects of the information they use and develop the ability to respond appropriately to broader circumstances. (Batty et al., 2012). To tackle the modern challenges posed by smart technologies, both citizens and tourists need to develop a solid understanding of geospatial concepts. (Roche, 2014). Future technologies or techniques that currently exist but need to be further developed could be an integration of video and GIS, integration of space, air, and ground sensors and GIS, indoor and underground navigation, Ubiquitous Sensing via smartphones, Volunteered Geographic Information (VGI), geospatial-temporal data mining, integration of geospatial services and artificial intelligence, virtual and augmented reality, etc. (Li et al., 2013).

Smart tourism destination governance

Smart tourism destination governance refers to how smart tourism destinations are managed and governed. It involves the coordination and cooperation between different stakeholders, such as government agencies, tourism industry organizations, and local communities, to develop and implement strategies that leverage technology and data to create more sustainable, efficient, and enjoyable visitor experiences. Geospatial understanding of smart tourism destination requirements from geospatial-temporal data can greatly improve management decisions, destination planning, destination marketing, and environmental protection, all of which are necessary to balance the experiences of tourists and residents at a destination (Supak et al., 2015; Stankov et al., 2022). The complexity of political, social, and economic processes and decision-making requires precise, reliable, real, and largely complete data. Most of this data is geospatially oriented (Dragović et al., 2019; Gruen, 2013). Local authorities and businesses can use geospatial approaches to define the demand market and demographic profile of their customers, enabling smarter data-driven decision-making (Supak et al., 2015). In addition to the fact that at the global level countries and cities are facing very serious challenges of new technologies and new standards and great efforts in building new achievements and capacities, nevertheless, there is a general agreement that the benefits of investing in geospatial enablement are multiple and that the efforts in this direction more than justified (Williamson et al., 2010). A comprehensive effort needs to be made to provide a clearer view of the design choices of smart city strategies, where geospatial referencing can play a fundamental role (Angelidou, 2014). Making this data available using geospatial technologies can help improve a destination's tourist experience and accessibility and improve overall support for tourists and residents in a smart destination (Coca-Stefaniak, 2020).

Methodology

Although a smart tourism destination should be viewed holistically, we can see that the whole of smart layers within a smart tourism destination, in addition to being divided into smart destination dimensions, can also be divided into specific implementations within those dimensions or a part or whole smart destinations into complete structure entities of smart initiatives, solutions, projects, and practices (Boes et al., 2015). Smart cities base their growth on smart initiatives and smart projects (Manville et al., 2014), similarly smart initiatives, projects, and practices are crucial for smart tourism destinations, as shown in Figure 1.

Research in Novi Sad was carried out in the digital archives of institutions, local government, and public companies, also the websites of the city administration and city institutions, strategic documents, budget documents, and public studies prepared by the City of Novi Sad were searched. Then The compendium of best practices, which was created as a result of the competition for the prestigious title of the European capital of smart tourism, was processed (European Commission, 2019). The next important source of data on smart projects was the media archive of the Naslovi net portal (Naslovi.net),

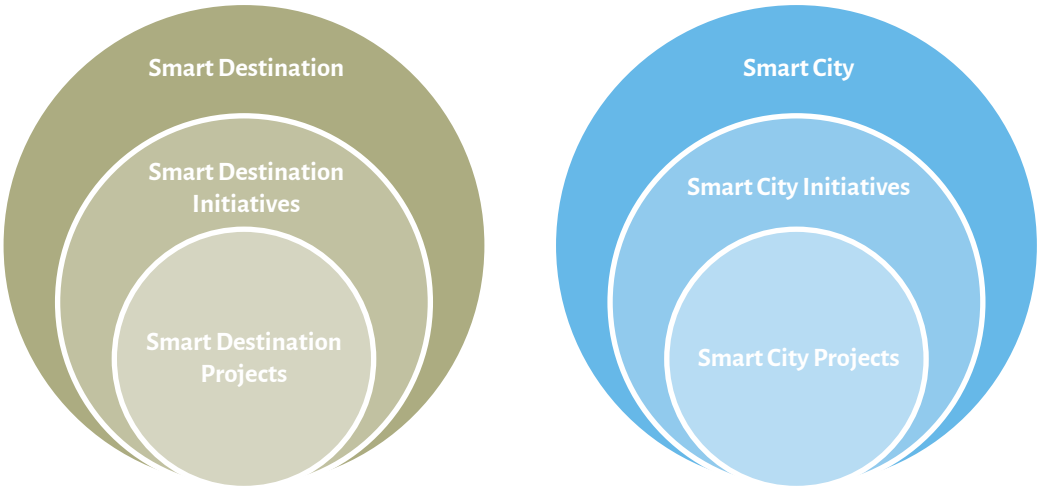

Figure 1. Fundamental relations between smart tourism destinations and smart initiatives, projects, and practices, are similar to the relationship between projects, initiatives, and cities
Source: Manville et al., 2014

whose search yielded information on a significant number of smart projects. At the same time, the portal is an aggregator and search engine of news in Serbian, which creates a unique cross-section of over 120 media sources, covering almost the entire media and information space of Serbia (Naslovi net, 2020). The previous three years, namely 2018, 2019, and 2020, were searched in the archives of the Naslovi net portal using the adjective 'smart' as a keyword, and also Google's service for downloading mobile applications Google Play with the keywords 'Novi Sad' and 'smart'.

When evaluating and classifying smart projects, special attention is paid to their geospatial aspects. The first thing, that needed to be defined, was the spatial coverage of the project itself. Next, is the project geospatially oriented? Is there a possibility or is it necessary to geospatially enable the project itself (Roche, 2014)? Which layer of the urban information model do these smart projects belong to (Harrison & Donnelly, 2011)? What are the types of primary and secondary data related to a smart project? What is the number of georeferenced data? What geodata topic does smart project data belong to? What level of geospatial literacy (Tao, 2013) corresponds to a smart project? Are basic geospatial data services used to find, view, download, transform, service call service, or perhaps additional geospatial data services: interaction, information management, work process management, spatial processing, thematic processing, temporal processing, metadata processing, and geospatial communication?

In the opinion of the authors of this article, 40 researched smart projects is a large enough number of projects that can provide, bearing in mind the limited possibilities of the physical scale of the research, a satisfactory volume and variety of collected data on the characteristics of smart projects to make relevant considerations and conclusions.

Case area

Novi Sad is located in the north of the Republic of Serbia as the administrative and economic centre of the Autonomous Province of Vojvodina. It lies on the banks of the Danube within the Pannonian plain. The wider area of Novi Sad has approximately half a million inhabitants. The city has a developed urban and tourist infrastructure, a highly educated workforce and a relatively efficient communal services system, and a high level of culture of living (Cimbaljević et al., 2021). The research covers the territory of the local self-government unit that extends within the municipality of Novi Sad.

Catalogue

The research of smart projects in Novi Sad aimed to create an original classification in the form of a catalogue, that is, the form of a database of characteristics that would be the basis for analysis and conclusions, but would also have practical value and applicability as a cross-section of the situation in Novi Sad. To translate the catalogue of projects into a table for machine calculation and achieve uniformity, a form was created to collect data on the characteristics of smart initiatives, projects, and practices.

Results

Based on the research of smart initiatives, solutions, projects, and practices in Novi Sad, a catalogue of Novi Sad smart projects was created, and after that, a database with the characteristics of smart projects was formed. Among the researched smart projects were a bike-sharing system, public city transport on internet maps, air quality monitoring, smart city cards, smart parking, smart benches and trees, tourist mobile apps, etc. The dominant providers of Novi Sad's smart projects are the local government and public companies, while private companies lag behind them. Almost all researched smart projects are applicable in Novi Sad, except for a small number such as smart taxi transport, for the implementation of which there are legal restrictions. According to the layers of the urban information model (Harrison & Donnelly, 2011), the most frequent are infrastructure and service projects. Some solutions are of high quality, and networking and sensors are used, but not artificial intelligence.

Among the 40 scrutinized smart projects, 21 employ networking, while sensors find application in 12, with potential integration in an additional 4 projects. Although artificial intelligence remains untapped, prospective integration for specific functions exists in 9 projects. Regrettably, the majority of Novi Sad's smart initiatives lack the incorporation of proven technologies in their execution. A noticeable dearth of artificial intelligence and cloud com-

Table 1. Smart initiatives, projects, and practices observed during research in Novi Sad.

№	The name of the smart project	№	The name of the smart project
1.	Bicycle counting stations	21.	Smart environmental activism
2.	Bike sharing system	22.	Smart garbage bins
3.	Children tourist guides	23.	Smart cultural district
4.	E-government	24.	A smart reporting system
5.	eTourist system	25.	Smart taxi transport
6.	Information about the accessibility	26.	Smart parking
7.	Public city transport on Internet maps	27.	Smart public lighting management
8.	Combining transportation	28.	Smart waste management
9.	Communication with Chinese tourists	29.	Smart traffic
10.	Vehicle access control	30.	Personal city assistants
11.	Local quality labels	31.	Geospatial data portal
12.	Local currency	32.	Open data portal
13.	Murals - open-air gallery	33.	Accessibility to the beach
14.	Air quality monitoring	34.	Accessibility for all
15.	Smart bus stops	35.	Electric car chargers
16.	Smart fortress	36.	Automated recycling machines
17.	Smart street	37.	A radar speed signs
18.	Smart city cards	38.	Tourist mobile apps
19.	Smart benches and trees	39.	Carbon neutrality
20.	Smart telephone booths	40.	WiFi for all

puting is evident, hinting that the city's smart projects may not fully realize their potential for innovation and efficiency.

During the assessment and categorization of smart projects, special emphasis is placed on their geospatial dimensions. The initial consideration involves defining the project's spatial scope, followed by an evaluation of its geospatial alignment. Additionally, the inquiry delves into the urban information model layer that these smart projects align with, as outlined by Harrison and Donnelly (2011). Examination encompasses primary and secondary data types associated with each smart project, along with quantifying the extent of georeferenced data. The investigation also identifies the geodata topic underpinning the smart project data, while establishing the corresponding level of geospatial literacy according to Tao's classification (Tao, 2013). The geospatial orientation of smart projects is perhaps the most significant feature on which data was collected for Novi Sad smart projects. There is a possibility or it is necessary to geospatially enable smart projects in Novi Sad (Roche, 2014).

Based on the data from the formed database of characteristics, 62% of smart projects are geospatially oriented, collect, process, and display geospatial data (geospatially and temporally referenced) and use geospatial technologies, most often GIS and GPS, while 23% of projects, there is the possibility of introducing geospatial elements and technology, which can be seen in the iceberg diagram on Figure 2.

About half of smart projects use, or can use, time referenced data. 7 researched smart projects do not operate with user data at all. That's almost three-quarters of projects that base their functioning on point geospatial data,

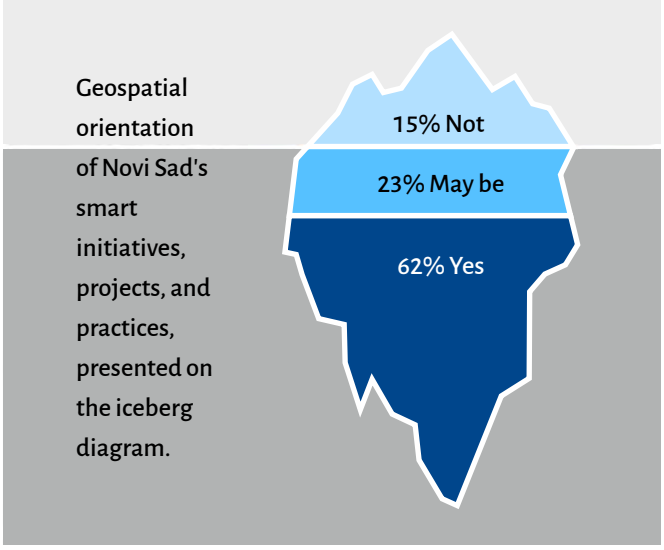

Figure 2. Geospatial orientation of Novi Sad smart initiatives, projects, and practices, presented on an iceberg diagram

and the data itself is almost equally often predominantly single, sets or databases. The predominant geometry of geospatial Novi Sad smart projects are points, and the data is placed in georeferenced databases. The most common geospatial services are services for finding and viewing data. Additional geodata services are less frequently represented, so that 22 projects do not use additional services. According to geospatial thematic categories, the most represented projects are in the category of society. For smart projects in Novi Sad, there is still plenty of room for progress on the scale of geospatial literacy. Geospatial literacy grows during the progress of development phases in cities and smart destinations, while among Novi Sad smart projects, the most represented with 85% are projects that possess the 2nd level of geospatial literacy (Tao, 2013), electronic maps, 2D geodatabases, and GIS.

Theoretical contribution

Although geospatial aspects are not in the foreground when considering the concept of smart tourist destinations, nevertheless, there is a considerable amount of research that supports the claim and forms a theoretical framework that geospatial aspects are important for smart tourist destinations. Geospatial technologies, as one of the ICTs, are crucial for providing a technological basis, a platform that forms the backbone of a smart environment of smart tourism destinations.

Most technologies for smart cities and smart tourist destinations are geospatially oriented, so smart cities and smart tourist destinations have a significant need for a geospatial approach in the process of planning, implementation, development, and management. Geospatial enablement, accessibility, openness, and literacy increase the quality of life of residents and the competitiveness of a smart tourist destination.

Geospatial technologies are key to providing a technological platform that forms the backbone of smart cities and smart tourism destinations. Positioning and guidance are of irreplaceable importance for all smart places, smart tourism destinations, and smart cities, as they involve locating and tracking. The smart city and smart place model is based on 2D digital maps and 3D digital city models, 4D geospatial-temporal databases, and points of interest. The integration of global positioning system (GPS) technology can provide accurate information about environmental locations for analysis for further environmental preservation. Indoor positioning system (IPS) and navigation based on it have a significant application in tourism in spaces such as museums, galleries, etc. Furthermore, integrating video with GIS can be a very useful technology in the fight against crime. The text highlights that remote sensors and smart infrastructure can generate large amounts of data that need to be processed and analyzed, and geospatial, temporal, and contextual information are critical components of this analysis. Therefore, geospatial technologies and information play a crucial role in enabling smart cities and smart tourism destinations.

Practical recommendations

Geospatial elements and georeferences are an integral part of analyses, plans, and reports of cities around the world and these documents clearly show that the need for geospatial analysis, research, and geospatial approach, methods, and tools is increasing (Stankov et al., 2012; 2016). On the other hand, geospatial aspects are rarely mentioned in expert and government reports concerning smart cities and smart tourism destinations.

GIS systems can serve as centralized information systems or platforms that integrate all aspects of the process in smart tourism destinations that want to be truly smart, including stakeholders, technologies, standards, and data, and can also integrate videos and visualize large data sets (Filimonau et al., 2022). For the planning and management of smart tourism destinations, it is necessary to use a wide range of modern technologies, among which geospatial technologies and data are a specially important factor. Contextually adapted geospatial services can be especially important (Radojević et al., 2020).

The City of Novi Sad has great opportunities for the implementation of smart initiatives, solutions, projects, and practices that can have a tourist application (Pavluković et al., 2020; Radojević, 2021). Judging by current practice, Novi Sad is moving faster towards a functional smart city than towards a smart tourism destination, which does not mean that it will reach that goal sooner. In any case, it would be useful for the City of Novi Sad to create its official and publicly available cadastre or catalogue of smart initiatives, projects, and practices.

Limitation and Further research

The basic limitation of this article, which concerns the number and completeness of data of the researched smart projects in Novi Sad could be overcome when the City of Novi Sad creates its official catalogue of smart initiatives, projects, and practices.

The direction of further research could be aimed at building a conceptual model that would alleviate the problem of collecting and scaling all types of data collected through smart city infrastructure at smart tourism destinations, which could be used to optimize services and increase competitiveness. Also, very significant future research could take into consideration the technological progress and development of the latest information-communication and geospatial technologies.

Regarding the territory where smart initiatives, solutions, projects, and practices were implemented, future research could include some other cities with a larger number of inhabitants or certain entire countries.

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Extreme Precipitations and their Influence on the River Flood Hazards – A Case Study of the Sana River Basin in Bosnia and Herzegovina

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KEYWORDS

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precipitation
water level
flood
remote sensing
mapping
risk zones

ABSTRACT

The subject of the research paper is the use of remote sensing in monitoring and analyzing the impact of climate change on the occurrence of extreme precipitation, and the cause-and-effect occurrence of floods in the area of the Sana River Basin in Bosnia and Herzegovina. The goal is to process the "product" of remote sensing to identify the time intervals of occurrence of extreme precipitation, to assess their impact on water levels, and to map potential floods in space. Spatial identification of zones that are at risk of flooding is an integral part of the aforementioned goal. Precipitation monitoring was performed by processing Climate Hazards Group InfraRed Precipitation with Station Data through the Google Earth Engine platform. The observed 30-year period (1992–2022) was compared with the average precipitation for 2017, 2018 and 2019. The impact of extreme precipitation on the water level of the Sana River was analyzed. Flooding periods have been identified: February and December 2017, March 2018 and May 2019. Mapping of flooded areas was carried out by pre-processing and post-processing of Sentinel-1 radar satellite images. The total flooded area is: 710.38 ha (February 2017), 496.79 ha (December 2017), 417.86 ha (March 2018) and 422.42 ha (May 2019). Based on the identified flooded areas, a flood risk map was created on the main course of the Sana River. The research contributes to a better understanding of the changes that occur in the area under the influence of climate change, and the data presented are important for numerous practical issues in the field of water resource management and flood protection.

Introduction

Climate change poses a threat to people around the world (IPCC, 2021). Changes in the intensity and frequency of climate change lead to the occurrence of extreme events, such as heavy and intense precipitation, which have a major impact on the management of water resources and flood risks (Meresa et al., 2022). Extreme precipitation affects the intensity and frequency of floods, creating major problems for aquatic and terrestrial ecosystems, including human societies and economies (Tabari, 2020). The monitoring of heavy precipitation intensity and frequency ena-

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bles the tracking of climate change effects (Bucchignani et al., 2016; Dong et al., 2021).

Today, it is possible to monitor precipitation based on the comparison of data from several sources. Data from hydrological and meteorological stations, and satellite data can be considered (Michaelides et al., 2009; Bai et al., 2018). Precipitation data obtained from hydrological and meteorological stations have high accuracy (Kidd et al., 2017), but they are spatially limited (Brocca et al., 2019). On the other hand, data obtained from weather radars have limiting characteristics in terms of data quality due to signal distortion (Raghavan, 2013). Satellite precipitation data cover large regions with high spatial and temporal resolution. The mentioned type of data has its shortcomings, which can be reduced to a minimum by post-processing actions (Maggioni et al., 2016). Accordingly, it is necessary to validate the satellite data on the estimation of precipitation based on the data of meteorological stations, to assess their precision and possibility of use (Loew et al., 2017; Kumar et al., 2019).

Extreme precipitation can lead to floods, which can result in big economic and human losses (Ward et al., 2013). For this reason, flood mapping and modelling processes are very important, in order to adequately assess the flood risk (Moel et al., 2009), but also the damage caused by this primary hydrological hazard (Amadio et al., 2016). Remote sensing "products" in the form of satellite images play a very important role in flood mapping and modelling, as well as modern platforms whose purpose is the efficient processing of this data. One such platform for geospatial processing of satellite data is Google Earth Engine (GEE). The mentioned platform is based on the cloud technology, and with it, it is possible to easily overcome the challenges and problems faced by traditional approaches when processing satellite images (Gorelick et al., 2017). There is a significant number of research whose focus is the analysis of climate change based on the processing of satellite images using the GEE platform (Pandey et al., 2022; Nghia et al., 2022; Rincón-Avalos et al., 2022).

The main objective of the present research paper is to monitor the impact of climate change on the occurrence of primary hydrological hazard in the form of floods. An integral part of the aforementioned goal is the identification of extreme precipitation that leads to flooding, and the identification of areas that are at risk of flooding. The research is based on the use of modern technologies, such as geographic information systems (GIS) and remote sensing. Therefore, the general novelty and importance of this study are answering the following scientific questions (SQ): SQ1 – To better understand the impact of climate change on the occurrence of extreme precipitation and the cause-and-effect occurrence of floods; SQ2 – To present the methodology that could be important for the identification of flooded areas after a natural disaster, and can be useful for many practical issues, such as the timely action of the competent institutions in order to prevent a large-scale disaster, assessing the consequences and identifying critical points for the construction of embankments and other protecting systems for preventing floods in the future.

Study area

The research area is the Sana River basin (SRB) located in Bosnia and Herzegovina (B&H) (Figure 1). The main geographical characteristics of the research area are given in Table 1. As part of the research, the emphasis was placed on the main course of the Sana River. The aforementioned river originates in Donja Pecka and is the largest tributary of the Una River. The source is located at 414 m above sea level, and the confluence is at 122 m above sea level. The main course of the Sana River is 146 km long. It is characterized by the Posavina variant of the pluvial-naval water regime, characterized by the highest water level in April and the lowest in August (Gnjato, 2018). According to the Köppen-Geiger climate classification (Kottek et al., 2016), the research area belongs to the Cfb climate type, which is characterized by moderately cold winters and warm summers.

Table 1. The main geographical characteristics of the SRB

Type of SRB geographical characteristic	SRB geographical information
Spatial distribution by municipalities	Novi Grad, Kostajnica, Prijedor, Oštra Luka, Bosanska Krupa, Banja Luka, Sanski Most, Ključ, Ribnik, Mrkonjić Grad, Krupa na Uni
Latitude	44.18°N–45.09°N
Longitude	16.29°E–17.09°E
Total geographic area (km²)	about 3470 km²
Average altitude	505 m
Average slopes	10.9°
Population number (in the thousands)	454
Spatial share in Sava basin (in %)	3.55

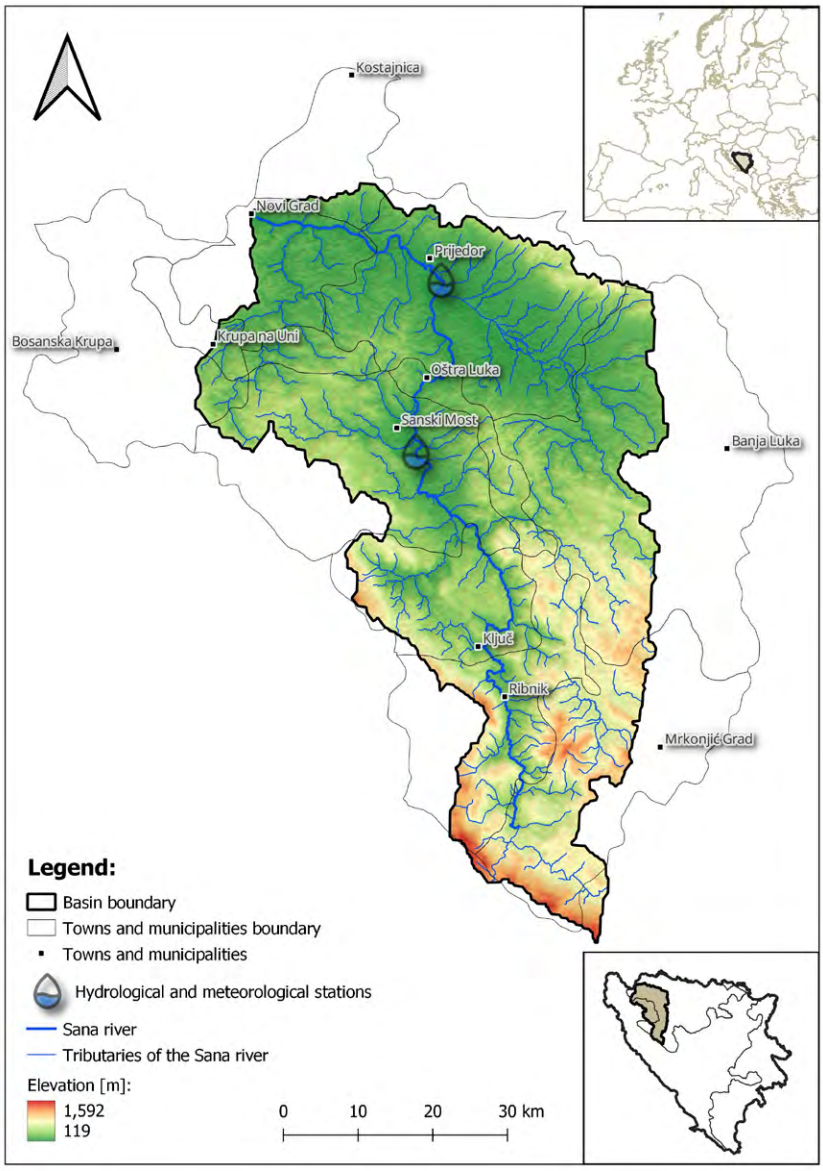

Figure 1. Location of the study area

Data used

Several input data were used in the research. The boundary of the SRB was taken from the HydroSHEDS database (https://www.hydrosheds.org/). The river network within the basin was taken from the EU-Hydro River Network Database (https://land.copernicus.eu/). Input data on precipitation were collected from meteorological stations Prijedor (44.97° N–16.70° E) and Sanski Most (44.77° N–16.67° E), while data on water level were collected from hydrological (HS) stations of the same name and location. The mentioned stations are not the only ones in the study area, but they are the only ones with complete, continuous and publicly available data for the defined time period of the research. The basis of the research is represented by satellite data on precipitation estimation called Climate Hazards Group InfraRed precipitation with Station data (CHIRPS). Mapping of flooded areas was performed by pre-processing and post-processing of radar Sentinel-1 satellite images.

Since 2014 the University of California, Santa Barbara distributes CHIRPS precipitation estimation data at different time intervals (daily, 5-day, 10-day, and monthly) (Funk et al., 2015). The precipitation data set is of a global character, and has relatively high spatial resolution data (0.05° x 0.05° ~ 5.3 km) and a long-term time coverage (1981 – almost real-time). The CHIRPS data processing algorithm combines satellite and measured precipitation estimates. All over the world, this type of data is subjected to the method of comparison with data obtained from meteorological stations. According to research, in terms of

bias and Pearson correlation coefficient, the CHIRPS dataset performs relatively well at the regional and global scale compared to other modern satellite precipitation data (Beck et al., 2017; Bai et al., 2018; Dinku et al., 2018).

Sentinel-1 are radar satellite images with high spatial resolution (10 m) and relatively good temporal resolution (about 6 days). The specification of these radar satellite images includes high-resolution Ground Range Detected, SAR sensor with C band (5.405 GHz), Interferometric Wide swath, from 30.4° to 46.2°, wide bandwidth (250 km) and double polarization (VV and VH) (Tran et al., 2022; Plank et al., 2014).

Methods

The process of monitoring the impact of climate change on precipitation, as well as the process of mapping flooded areas, was carried out by processing satellite data. The GEE platform based on cloud technology was used for processing. The research includes the processing and use of satellite data on precipitation, deviations in precipitation patterns, identification of extreme precipitation, assessment of the consequences on the water level, cause-and-effect mapping of flooded areas, and identification of spatial zones that are at risk of flooding. The research time period for precipitation is 1992–2022 year, and for the water level 2001–2019 year. The identification of flooded areas was carried out for the reference years (2017, 2018 and 2019).

The process of validating satellite data on precipitation was performed by comparing the mentioned data with data obtained from meteorological stations. The data on the average amount of precipitation per month for the defined time period of the research were validated. In order to find the interdependence between the impacts of climate change on precipitation, the 30-year average precipitation (1992–2022) was compared with the reference years (2017, 2018 and 2019). The goal is to identify precipitation extremes during reference years that "bounce" from the 30-year average precipitation. In parallel with this process, data on the average water level were also considered, in order to establish the reflection of extreme precipitation on the water level. Data on the average mean water level for the research period (2001–2019) were compared with the data of the reference years (2017, 2018 and 2019) (Figure 2). The goal of the presented approach is the spatial identification of the flood, which due to the extreme water level should occur first at the HS location, and then causally and consequently at other locations in the basin. The periods in which there is a clear difference in the amount of

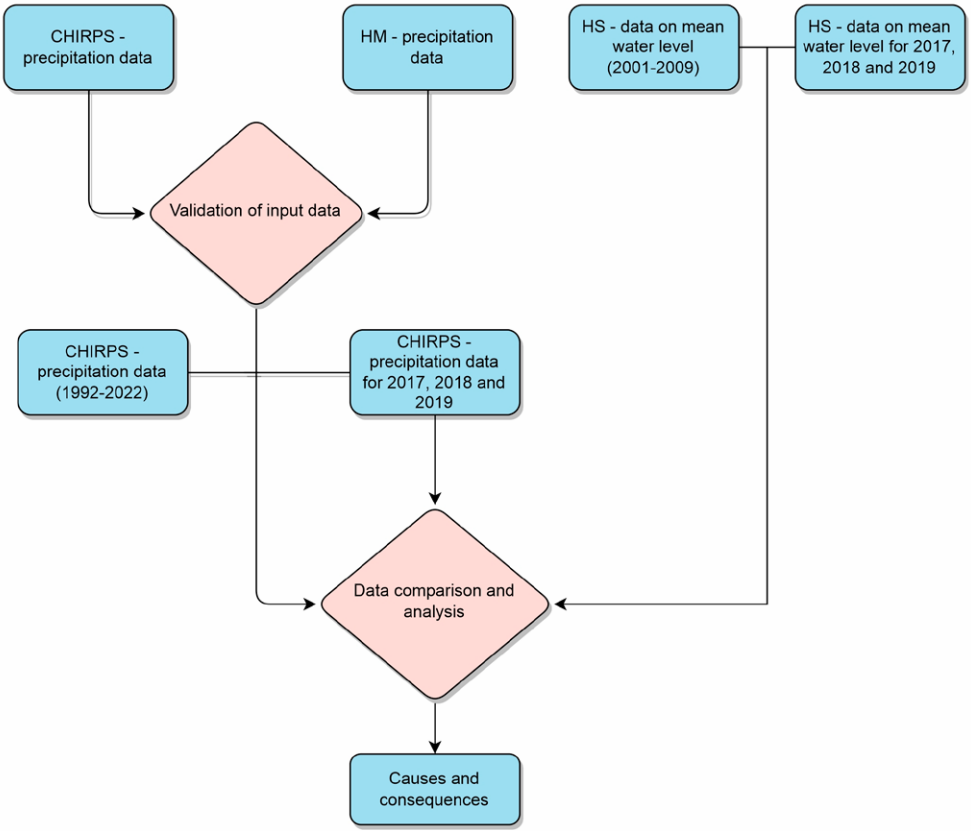

Figure 2. Algorithm for processing data on precipitation and water levels

precipitation, and a clearly differentiated extreme level of water, represent temporal data for the mapping procedure and determining the spatial extent of flooding in the research area.

The process of mapping flooded areas was carried out by pre-processing and post-processing of Sentinel-1 radar satellite images (Figure 3). The first step represents the filtering of satellite image characteristics (product type, polarization and sensor operation mode). Automated pre-processing of the filtered satellite image is then performed (reducing the image to the study area, applying orbit file and thermal noise removal). A post-processing process was performed on the pre-processed satellite images. For selected time periods within the reference years (before and during/after floods), two mosaics are created in the form of raster data models – the first mosaic to map the permanent part of the watercourse, and the second to map the spatial extent of the flooded areas. A speckle filtering procedure is applied to both mosaics, in order to reduce the possibility of incorrectly mapping areas that do

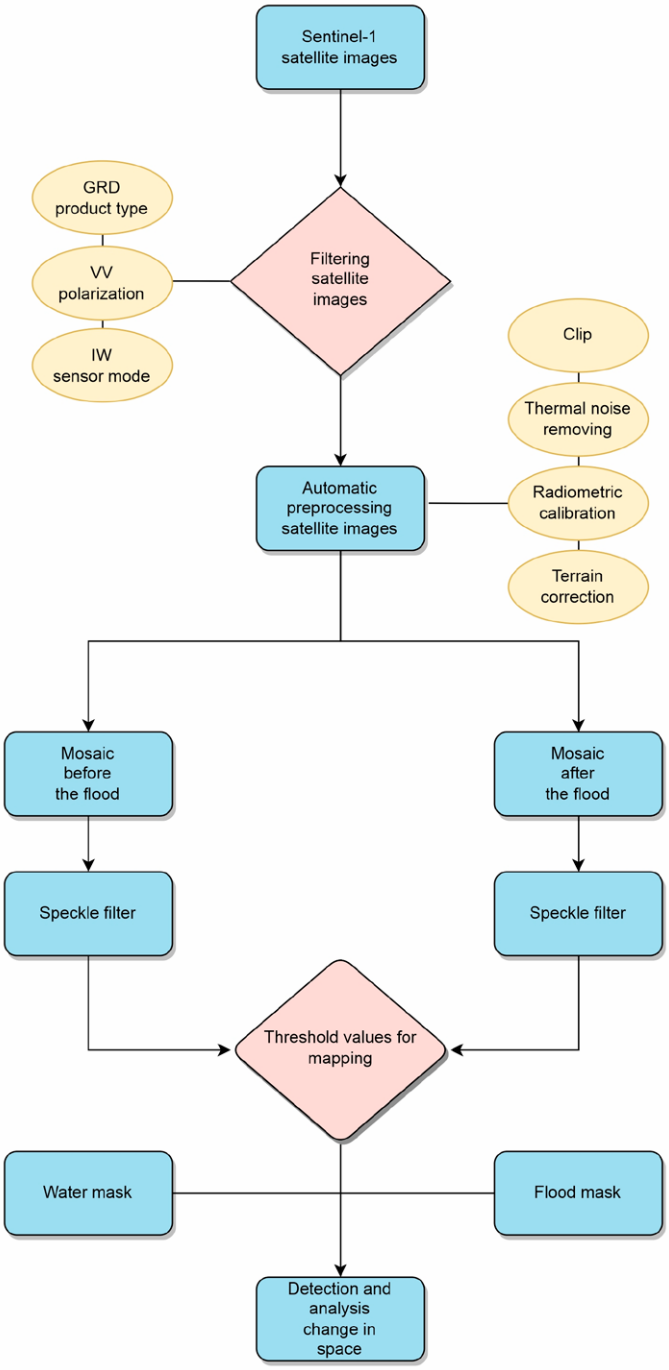

Figure 3. Algorithm for processing satellite images for flood mapping

not represent water bodies as water bodies. A filtered mosaic in the form of a raster data model is the basis for mapping. The mapping process is carried out on the basis of the numerical value of pixels, that is, through the definition of a numerical threshold value for distinguishing flooded areas from other areas. With this process, the final result is obtained in the form of a permanent water surface mask and a flooded surface mask, over which the process of detecting and analyzing changes in space is performed, as well as the process of identifying zones at risk of flooding.

Results

The validity assessment of CHIRPS satellite data on precipitation estimation was performed by comparing the same with data obtained from meteorological stations Prijedor and Sanski Most for a 30-year time period (1992–2022). CHIRPS satellite data on spatial precipitation estimates vary, where each pixel depicts a different precipitation value for the area it covers. As part of this research, in order to evaluate the validity of CHIRPS data, algorithms were developed using the GEE platform. The CHIRPS average amount of precipitation per month at the level of the entire research area was calculated (one numerical value in the form of the average amount of precipitation for each month of the year for a 30-year time period). On the other hand, taking into account orography of the area (in accordance with the location of the stations), data from meteorological stations Prijedor and Sanski Most were combined. Based on the combined data of both meteorological stations, the average amount of precipitation per month for the mentioned 30-year time period was calculated. The obtained results were compared with each other (Figure 4). During April and September, the CHIRPS data almost matches the meteorological data. January, February, March, May, June, July, August and October are characterized by minimal deviation of CHIRPS data from real ones (< 8%). A significant deviation is visible during November and December. The reason for the deviation in the mentioned months is explained by the occurrence of snowfall, which caused a partial distortion of the satellite data. Likewise, the challenge of comparing "polygon" and "point" data needs to be considered. Namely, the CHIRPS data depict the average value of the amount of precipitation per month in the entire basin area, while the data on the average amount of precipitation from meteorological stations refer to two locations in the area of the basin. In this respect, it is necessary to point out the lack of a meteorological station at higher altitudes of the basin. In addition to the meteorological stations Prijedor and Sanski Most, there are no other stations at the level of the study area that have continuous data for the defined time period of the research. Considered all the above mentioned, as well as the presented comparison results, it is concluded that the CHIRPS data are valid for the further research.

CHIRPS monthly average precipitation data (1992–2022) are overlaid with monthly average precipitation for reference years (Figure 5). The goal for reference years is to identify months with a significantly higher amount of precipitation then the 30-year average. According to the authors, months with a higher amount of precipitation represent those where the average amount of precipitation is > 20 mm in relation to the average amount of precipitation per month during the 30-year period. During 2017, a higher amount of precipitation than the 30-year average was

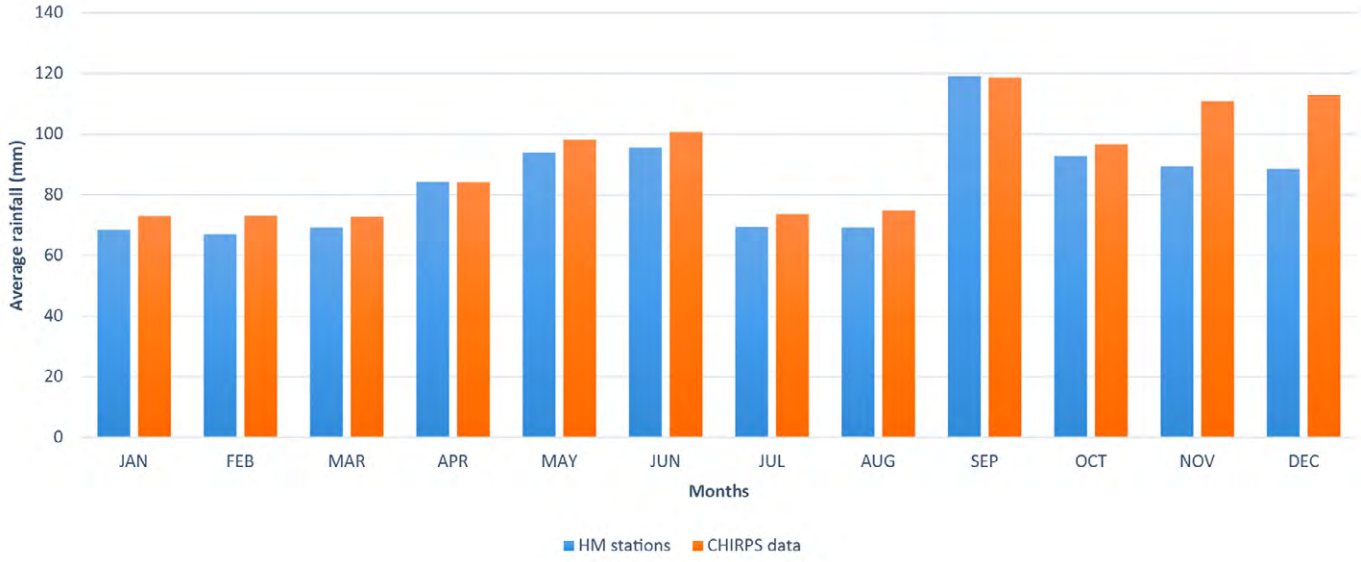

Figure 4. Average precipitation by month (1992–2022) for study area

Figure 5. Comparison of the CHIRPS average amount of precipitation by month (1992–2022; 2017, 2018 and 2019)

recorded in February (> 21.2 mm), September (> 61.6 mm) and December (> 57.2 mm). A higher amount of precipitation during 2018 is visible in February (> 40.1 mm), March (> 79.1 mm), May (46.2 mm) and June (> 28.7 mm). During 2019, a higher amount of precipitation was recorded in May (> 69.5 mm), November (> 45.6 mm) and December (> 42.4 mm). Indicatively, there is a well-founded suspicion that during the months with a higher amount of precipitation than the 30-year average, floods could have occurred at the level of the study area.

In order to more clearly differentiate the time periods of occurrence of floods in the study area, the impact of recorded extreme precipitation on the water level of the Sana River was analyzed. For this reason, the data on the average mean water level by month (2001–2019) are overlaid with the average mean water level during the reference years (2017, 2018 and 2019) (Figure 6). The goal for the reference years is to identify the months whose average mean water level is higher than the 18-year average. According to the authors, the months during which the average mean water level is > 25 cm compared to the 18-year average can be interpreted as the time period when the floods occurred, and when it can be clearly mapped in space by processing satellite images. It is possible to identify floods in space even during smaller increases in the mean water level, but due to limitations in terms of the spatial resolution of satellite images, it is not possible to map them accurate and precise. The extreme amount of precipitation from February 2017 were reflected in the average mean water level of HS Prijedor (115 – 155 cm), and the same trend continued during the month of March (154.6 – 173 cm). During February 2017, a small difference in the increase of the average mean water level was noticeable on HS Sanski Most (172.2 – 176 cm). The extreme amount of precipitation in September of the mentioned year did not affect the average water level. The occurrence of extreme precipitation that did not affect the water level can be explained by the fact that during the previous months (May–August) the amount of precipitation was less than the 30-year average. During the mentioned period, the ground was not saturated with water, and therefore the precipitation that occurred during this period could not cause a higher water level, nor the potentional occurrence of floods. Extreme amounts of precipitation in December 2017 were reflected in the average mean water level of HS Prijedor (105.4 – 133 cm) and HS Sanski Most (169.3 – 178 cm). The trend from December 2017 continued in January 2018, so during the mentioned period a higher level of the average mean water level was recorded at HS Prijedor (99.5 – 144 cm) and HS Sanski Most (166.1 – 169 cm). The precipitation in February did not significantly affect the average water level, which for this month was almost identical to the 30-year average at HS Prijedor, while at HS Sanski Most it was below the 30-year average. The extreme amount of precipitation from March 2018 was reflected in the average mean water level of HS Prijedor (154.6 – 256 cm) and HS Sanski Most (196.5 – 239 cm). In addition to extreme precipitation, the melting of snow in the higher altitudes of the basin could potentially have contributed to the water level for March 2018. The trend of higher precipitation in May and June 2018 was not followed by a noticeably high average water level. Precipitation from May 2019 had a significant effect on the average mean water level of HS Prijedor (101.3 – 183 cm) and HS Sanski Most (172.4 – 186 cm). Due to the lower amount of precipitation in October, the precipitation from November did not leave a clearly visible mark on the average mean water level, while for the month of December the differences are negligible.

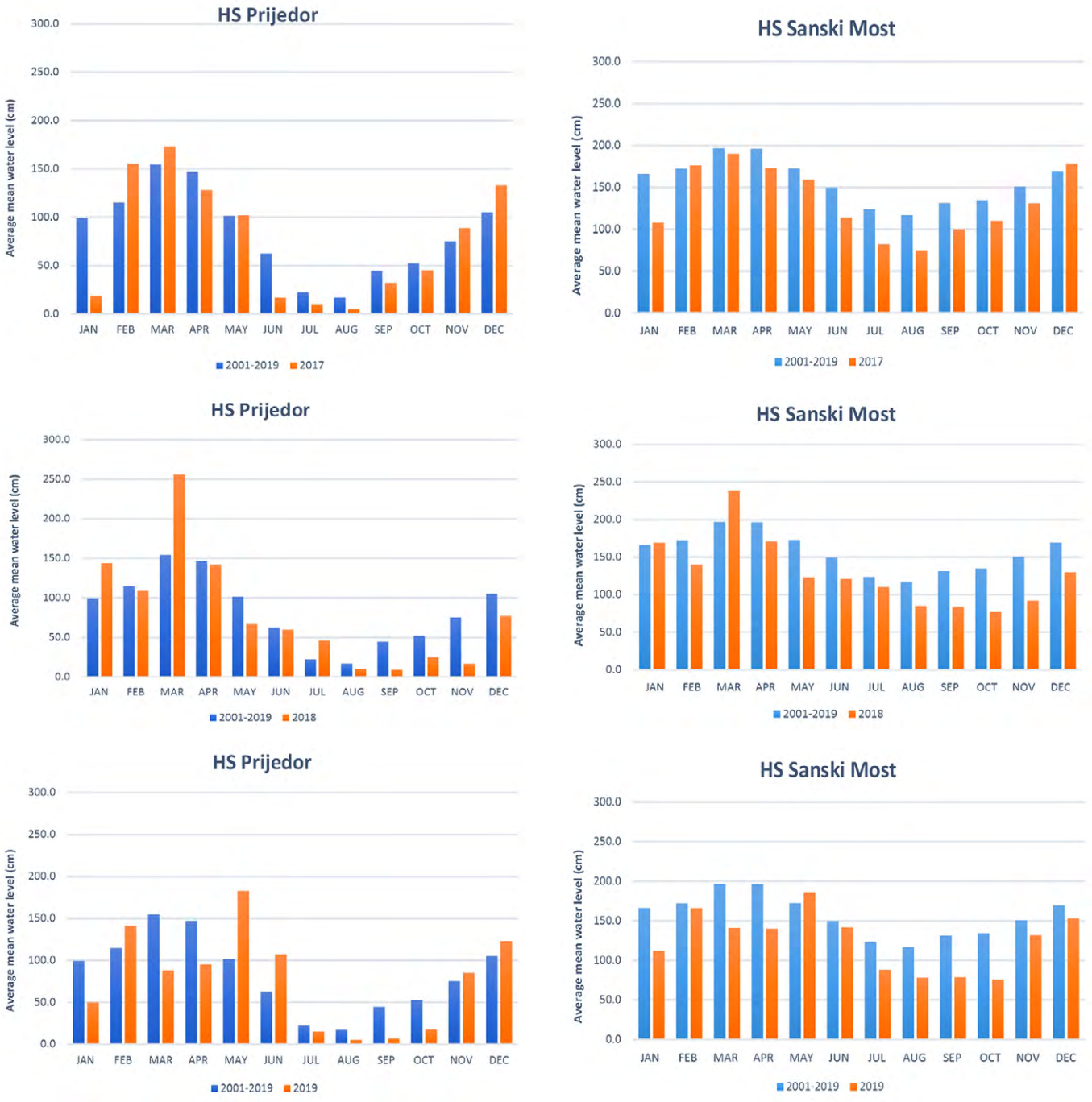

Figure 6. Comparison of the average mean water level of HS Prijedor and HS Sanski Most (2001–2019; 2017, 2018 and 2019)

Based on the comparative analysis of the average amount of precipitation during the 30-year period and the reference years, and the comparative analysis of the average mean water level for the 18-year period and the reference years, it is concluded that the potential mapping of floods with clearly separated spatial extents can be determined for February and December (2017), March (2018) and May (2019).

By applying the remote sensing method, and by processing and analyzing radar Sentinel-1 satellite images, flood mapping algorithms were developed. Running the algorithms through the GEE platform, the mapping of flooded areas was carried out at the level of the study area for previously defined time periods (Figure 7). The mapped flooded areas from February and December 2017, as well as March 2018, have similar spatial extents. During the mentioned periods of time, there was a dominant overflow of the river Sana from the riverbed in its middle and lower course. Also, during all three mentioned periods, there was a significant overflow of the Japra River, which is a left tributary of the Sana River. The total flooded area of the floods from February (2017) is 409.44 ha, December

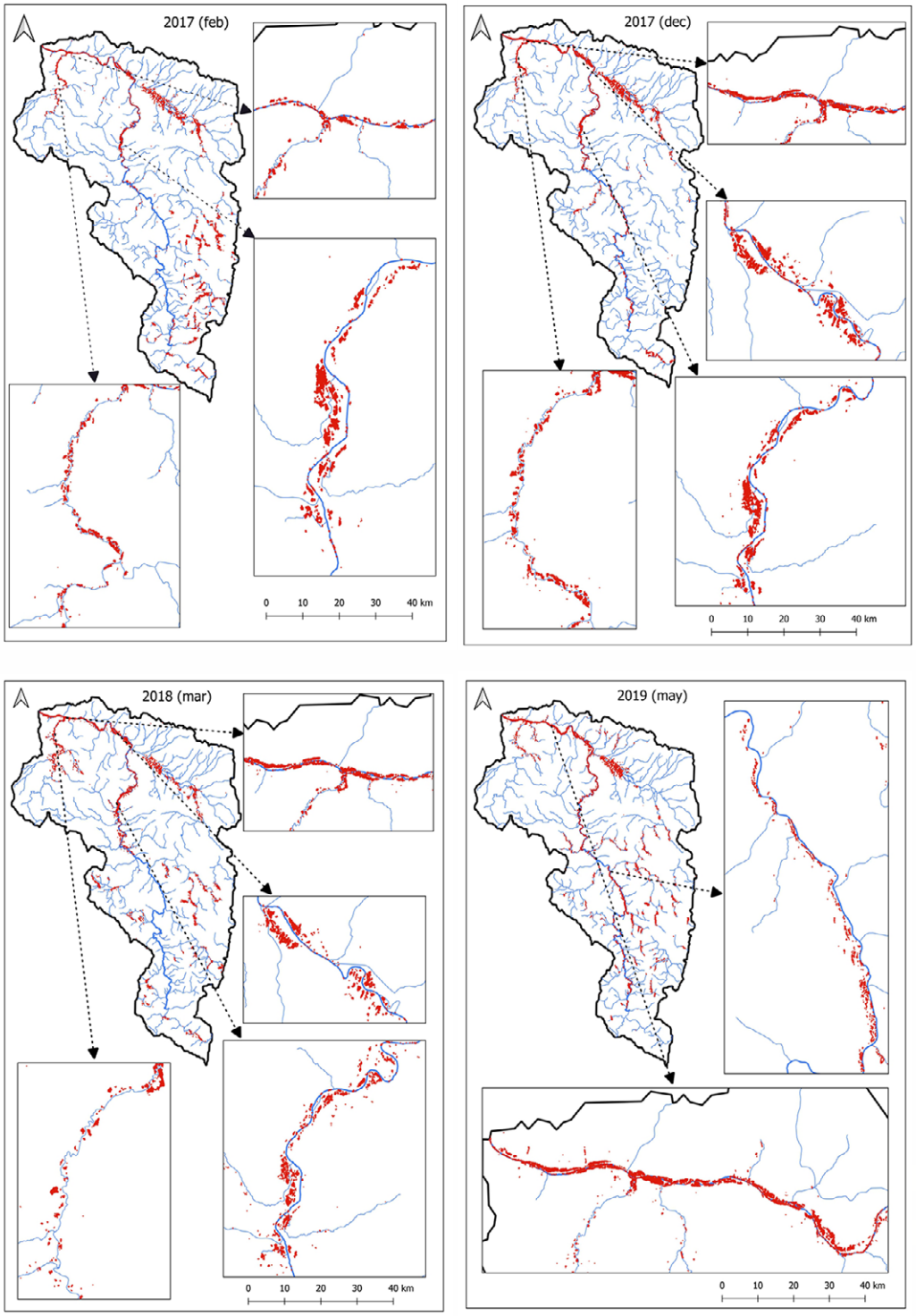

Figure 7. Mapped flooded areas

(2017) 497.10 ha and March (2018) 417.88 ha. The floods of May 2019 were characterized by the dominant overflow of the Sana River in the lower reaches in the area of the municipality of Novi Grad and the city of Prijedor, while the overflow and flooding of the Japra were insignificant. The total flooded area in May 2019 was 422.54 ha. Given that the mapped floods are characterized by a similar spatial extent, it is concluded that the municipalities and cities that were most affected by the floods were: Novi Grad, Prijedor, Oštra Luka, Sanski Most and Ključ.

The map of flooded areas from 2017, 2018 and 2019 was the basic input data for creating a map of flood risk zones, and it was created for the main course of the Sana River, i. e. the cities and municipalities that were most affected

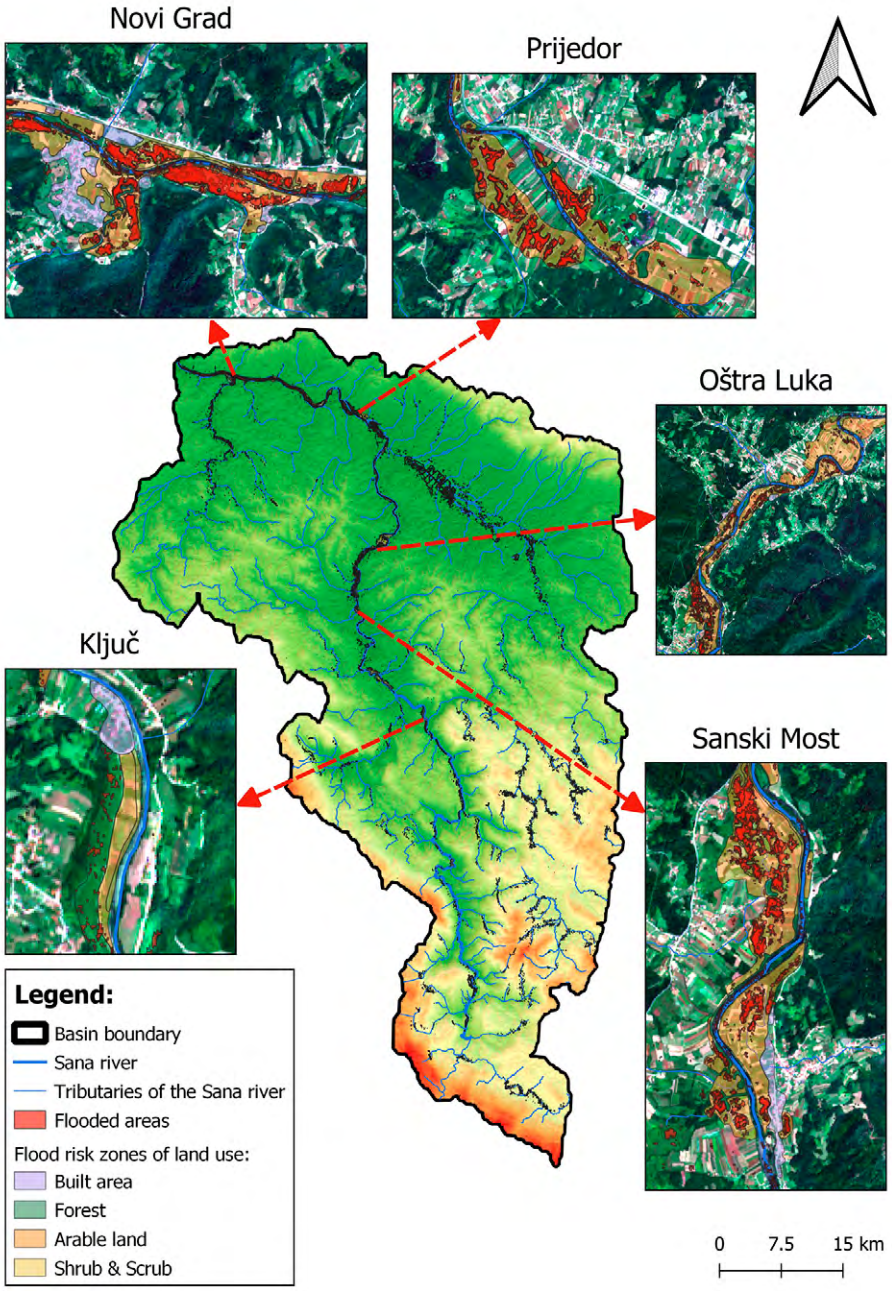

Figure 8. Flood risk zones

by floods (Novi Grad, Prijedor, Oštra Luka, Sanski Most and Ključ) (Figure 8). Based on the successive overlapping of mapped floods from the mentioned years and the satellite base, the ways of land use located in the flood risk zones were identified, which include: built areas, forest areas, arable land and scrub & shrub.

In Novi Grad, the total area of the floods risk zone is 666.63 ha, of which 71.97 ha are built areas, 62.38 ha of forest areas, 488.33 ha of arable areas and 43.95 ha of shrub & scrub areas. Bulit areas that are at risk of flooding include the urban center of the municipality and settlements: Blagaj Japra, Svodna, Blagaj Rijeka, Vitasavci and Trgovište. According to the last census from 2013, 11,923 inhabitants live in the threatened area (Republika Srpska Institute of Statistics, 2017). The total area of the flood risk zone in the city of Prijedor is 616.59 ha, of which 48.88 ha are built areas, 50.46 ha are forest areas, 500.23 ha are arable areas and 17.02 ha are shrub & scrub areas. Built areas that are at risk of flooding include the urban center of the city and settlements: Rasavci, Brezičani, Čarkovo, Ništavci, Gomjenica, Miljakovci and Donja Dragotina. According to the last census from 2013, 34,636 inhabitants live in the threatened area (Republika Srpska Institute of Statistics, 2017). The municipality of Oštra Luka is smaller in area than Novi Grad and Prijedor, so its total area of the flood risk zone (260.79 ha) is therefore smaller. The area of

land use that is at risk of flooding in Oštra Luka is 8.47 ha for built areas, 15.74 ha for forest areas, 225.32 ha for arable areas and 11.26 ha for shrub & scrub areas. Built areas that are at risk of flooding include the urban center of municipality and settlements: Koprivna and Usorci. According to the last census from 2013, the total number of inhabitants who live in the threatened area is 1,725 (Republika Srpska Institute of Statistics, 2017). In Sanski Most, a total of 408.64 ha are at risk of flooding, of which 15.42 ha are built areas, 40.93 ha are forest areas, 339.67 ha are arable areas and 12.62 ha are shrub & scrub areas. Built areas that are at risk of flooding include the urban center of municipality and settlements: Trnova, Vrhpolje and Sasina. According to the last census from 2013, 20,025 inhabitants live in the threatened area (Agency for Statistics of Bosnia and Herzegovina, 2019). Ključ is the municipality with the smallest area of risk of flooding compared to the other analyzed municipalities and cities. The total area of the flood risk zone is 108.39 ha, of which 6.68 ha are built areas, 73.77 ha are forest areas, 26.16 ha are arable areas and 1.78 are shrub & scrub areas. Built areas that are at risk of flooding include the urban center of municipality and settlement Kamičak. According to the last census from 2013, the total number of inhabitants who live in the threatened area is 5,800 (Agency of Statistics of Bosnia and Herzegovina, 2019) (Table 2).

Table 2. Types of land use under the risk of flooding

	Built areas (ha)	Forest (ha)	Arable land (ha)	Shrub & Scrub (ha)	Total (ha)
Novi Grad	71.97	62.38	488.33	43.95	666.63
Prijedor	48.88	50.46	500.23	17.02	616.59
Oštra Luka	8.47	15.74	225.32	11.26	260.79
Sanski Most	15.42	40.93	339.67	12.62	408.64
Ključ	6.68	73.77	26.16	1.78	108.39
Total (ha)	151.42	243.28	1579.81	86.63	2061.04

A total of 151.42 ha of built area, 243.28 ha of forest area, 1579.81 ha of arable area and 86.63 ha of shrub & scrub areas are under the flood risk zone in the observed area. The total area at risk of flooding is 2061.04 ha, of which 666.63 in Novi Grad, 616.59 ha in Prijedor, 260.79 ha in Oštra Luka, 408.64 ha in Sanski Most and 108.39 ha in Ključ. The total number of inhabitants of populated areas within which the zones of risk of flooding of built areas have been identified amounts to 74,109. Identified spatial areas located in the flood risk zone should in the future represent priority areas for the construction of systems and infrastructure in the function of flood protection.

Discussion

During the last decade, an increased frequency of years with extreme precipitation that resulted in catastrophic floods has been observed in B&H (Popov et al., 2017). Within this research, the occurrence of extreme precipitation in the area of the SRB is based on the processing of CHIRPS satellite data on precipitation estimation. According to Pacca et al. (2020), CHIRPS are characterized by homogeneous, standardized and continuous time series of data. The research results of the mentioned authors point out that CHIRPS data are significant for areas characterized by a small number of meteorological stations. Given that there are only two meteorological stations with continuous data for a 30-year time period (1992–2022) in the area of SRB, CHIRPS data represent the optimal solution for monitoring and identifying extreme precipitation. Ciric et al. (2018) successfully ranked precipitation extremes according to duration (1, 3, 5, 7 and 10 days) for the Danube River Basin area based on CHIRPS data. Gao et al. (2018) investigated the long-term characteristics of precipitation in the Xinjiang region of China (1983–2014). According to the results of the mentioned authors, CHIRPS performs well with respect to monthly and annual precipitation data. Zhang et al. (2022) conclude that CHIRPS data show high accuracy in precipitation estimation (coefficient of determination $R^2 < 0.92$). Bai et al. (2018) compared CHIRPS data with precipitation data from meteorological stations in China (1981–2014). The results showed a good agreement of CHIRPS (compared to data from meteorological stations) in areas characterized by a higher amount of precipitation. However, according to Paredes-Trejo et al. (2020) CHIRPS has limitations in reproducing the orographic precipitation due to the adoption of a fixed IRP CCD threshold value (i.e., 235 K), leading to classify warm orographic clouds as nonprecipitating (Dinku et al., 2018). Even though orographic clouds are relatively warm, they can produce substantial amounts of rain (Correia Filho et al., 2019). Wu et al. (2019) conclude that CHIRPS data perform well in estimating average monthly precipita-

tion, but also overestimate total annual precipitation. In the area of the SRB, a high degree of agreement between CHIRPS data and data from meteorological stations were established. However, looking at the months, a minimal overestimation of the CHIRPS data in relation to the data from meteorological stations is noticeable, and the same result is also visible on the summary average of precipitation for the 30-year period (1006.7 mm [meteorological data] – 1089.71 mm [CHIRPS]). Katsanos et al. (2016) established for the Cyprus area (1981–2010) a high degree of correlation of CHIRPS data regarding the identification of extreme precipitation. The mentioned authors emphasize the high correlation of CHIRPS extreme precipitation in relation to meteorological precipitation data in January, February and December. Their results indicate that meteorological stations at higher altitudes have a higher degree of correlation with CHIRPS data. A similar matching pattern is also visible in the SRB, where January, February and March are characterized by matching CHIRPS data by > 92% compared to meteorological data. The smaller data match in December is explained by the lack of meteorological station at higher elevations of the basin, which, taking into account the results of the aforementioned research, would affect the overall greater matching of precipitation throughout the year, and especially during the winter months.

As part of this research, thanks to CHIRPS data, the occurrence of extreme precipitation was observed three years in a row (2017, 2018 and 2019). In addition to extreme precipitation, in the area of the SRB, Ivanišević et al. (2022) established the number of days with higher water levels (2018 and 2019) that exceeded the emergency flood protection elevation. The presented results indicate the regularity of the occurrence of extreme precipitation, which leads to higher water levels, and the cause-and-effect occurrence of floods. The aforementioned results and research are supported by the successful mapping of flooded areas along the Sana River in 2019 (Sabljić & Bajić, 2021). According to Prokić et al. (2019) flooding is the most widespread natural hazard in Europe. Modern technologies and data, such as GIS and remote sensing, play a very important role in monitoring and identifying flooded areas. DeVries et al. (2020) developed algorithms for efficient flood mapping in the area of Texas (USA), Greece and Madagascar by processing Sentinel-1 and Landsat satellite images using GEE platform. Vanama et al. (2020) successfully mapped floods caused by extreme precipitation in August 2018 in India. The results of the mentioned authors in the form of mapped floods based on the processing of Sentinel-1 radar satellite images are based on the application of a numerical threshold value, and according to similar principle, by processing the same satellite images, floods were successfully mapped in the area of SRB. In addition to the mapping of the flooded areas, it is necessary to look at the consequences that the flood has on the environment. According to the results of Sarkadi et al. (2022) on the basis of satellite and other spatial data, flood susceptibility maps on the territory of Hungary were created. Samuele et al. (2021) mapped the floods in the area of northwestern Italy that were caused by the overflowing of the Sessia River. The result of research by the aforementioned authors determined that agricultural areas were the most affected by floods. Similar to the mentioned results, on the basis of the mapped flooded areas in the SRB, a map of the risk of flooding of various uses was created, which established the vulnerability of agricultural areas in the first place.

Conclusion

Monitoring of climate changes at the level of the study area for a defined period of time identified extreme precipitation, which was reflected in the water level, and causally and consequently caused the appearance of a primary hydrological hazard in the form of flooding. The identification of extreme precipitation three years in a row with catastrophic consequences in the form of floods indicates the negative impact of climate change in the research area. Thanks to advanced technologies such as GIS and remote sensing, as well as pre-processing and post-processing capabilities of satellite data, recurring patterns of floods with similar spatial characteristics during 2017, 2018 and 2019 have been identified. It was established that the municipalities through which the Sana River flows are the most affected by floods in the basin area, namely: Novi Grad, Prijedor, Oštra Luka, Sanski Most and Ključ. Given that floods were repeated year after year with similar spatial contours, a map with flood risk zones of different types of land use (built areas, forests, arable land and scrub & shrub) was created based on their mapping.

The paper shows the importance of satellite data in the monitoring of climate change and the identification of hazards that arise as a consequence of climate change. CHIRPS satellite precipitation data available from 1981 to near real-time, enabled effective monitoring of changes over a wide time span (1992–2022). The limiting factor of the research was the unavailability of data on precipitation from meteorological stations for the period before 1992 and data on water levels before 2001. The availability of this data would lead to a more accurate identification of time periods with the occurrence of floods in the area. Also, satellite data with a higher spatial resolution than the ones used would contribute to a more precise identification of flooded areas. The results of the research are significant for many

practical issues in the field of safety and flood protection, and the presented data can be useful to competent institutions when developing flood protection strategies and projects, as well as assessing the damage and consequences of floods. A further step forward in relation to the presented research would involve the determination of different scenarios that would include: the types of economic activities in the potentially affected area, industrial facilities that could cause sudden water pollution during floods, and the identification of protected areas at the level research that may be affected by flooding. By integrating these aspects into the existing research, a more accurate and complete "picture" of the consequences that floods can cause in the study area would be obtained.

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Did Hydroclimate Conditions Contribute to the Political Dynamics of Majapahit? A Preliminary Analysis

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Majapahit

ABSTRACT

Majapahit was the largest Hindu-Buddhist empire that ruled the Indonesian archipelago from the late 13th to mid-16th centuries CE. Only now there is still a lot of history surrounding the Majapahit era that has yet to be revealed. One is about how environmental factors influenced the political dynamics at that time. This study tries to discuss the influence of hydroclimate regimes using the Paleo Hydrodynamics Data Assimilation (PHYDA) product on the political history of Majapahit during the dry season, which occurs during the boreal summer. We conducted a spatial analysis of the area of drought by taking data from the Palmer Drought Severity Index (PDSI) in the Maritime Continent (MC) for six crucial episodes in the history of Majapahit, namely during the reign of Jayanegara (1309 - 1328 CE), which was marked by various political instability, the golden age of Majapahit (1309 - 1328 CE). 1350 - 1389 CE), the time of the Paregreg civil war (1405 - 1406 CE), the great famine event (ca. 1426 CE), the *candrasengkala* event (1478 CE), and in 1527 CE, which was marked by the complete conquest of Majapahit by the Demak sultanate. The results show statistically significant differences in most of these six episodes (except during the heyday of Majapahit) against the reference period, which is the average PDSI over the entire Majapahit era (1293 - 1527 CE). In addition, we also conducted a temporal analysis linking PDSI with shifts in the West Pacific Inter Tropical Convergence Zone (WP ITCZ) and El Niño Southern Oscillation (ENSO) represented by Niño 3.4 Sea Surface Temperature (SST). This temporal analysis results show a positive correlation between WP ITCZ - PDSI, a negative correlation between Niño 3.4 SST - PDSI and a negative correlation between ITCZ - Niño 3.4 SST. All of these correlations are statistically significant. So the probable cause of dry/wet conditions in MC during the Majapahit era was triggered by a meridional ITCZ shift which triggered different ENSO phases through Bjerknes feedback. This preliminary study has implications as opening the way to understand the influence of environmental factors on political conditions in the Majapahit era in more detail.

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Introduction

Majapahit (1293 - 1597 Common Era (CE)) was the largest thalassocracy empire in the history of the Indonesian archipelago (Noorduyn, 1978; Muljana, 2005; Djafar 2009; Rahardjo et al., 2011) (Figure 1). In addition, Majapahit can also be said to be one of the kingdoms that held power for the longest time throughout the classical Hindu-Buddhist period in the Indonesian archipelago (Djafar, 2009; Rahardjo et al., 2011). Although Majapahit was a monarchical kingdom with a centralized government, the pattern of its government was not far from the patronage of its vassal states, commonly known as the mandala concept (Wolters, 1999), which was often applied to kingdoms in the classical Hindu-Buddhist period in Southeast Asia. This pattern of power often causes political instability. According to the old Javanese eulogy *Nagarakretagama* (Coedes, 1975), its power spanned Java, Sumatra, the Malay Peninsula, and Kalimantan to eastern Indonesia, although historians still debate its territory (Lombard, 1969; Ricklefs, 2008; Ricklefs et al., 2010).

Unraveling the history of Majapahit, from its collapse to the emergence of Islamic sultanates in Java, makes us discover various important astonishing events. Political intrigue, war strategies, territorial expansion, and cultural battles are important events that have indirectly formed a new civilization in the Indonesian archipelago. Majapahit's cultural heritage can be seen in architecture and the political, social, cultural, and economic realms (Noorduyn, 1978; Lombard, 1969). Majapahit's power, which extended to the entire Indonesian archipelago, shaped Indonesian culture. In the political realm, when the Indonesian archipelago was reunited with the Republic of Indonesia, the idea of the legacy of Majapahit emerged in the concept of national leadership. Like the Indonesia motto, *Bhineka Tunggal Ika* (unity in diversity), it is none other than a pearl of wisdom composed by Mpu Tantular, a Majapahit poet in the 14th century CE (Djoened and Poesponegoro, 2008). Since Islam occupied the archipelago, the Hindu-Buddhist kingdoms seemed to have lost their political power. Islam sultanates then succeeded in becoming important political players. According to Ricklefs et al. (2010), Majapahit occupies a very important position in the archipelago's historical dynamics. Majapahit has brought the fragrance of the archipelago's earth to various parts of the world, especially the Southeast Asian region. Majapahit splendor and military strength under the leadership of Hayam Wuruk, as a king, and Gajah Mada, as a prime minister, made Majapahit respected by foreign nations.

Although, since its founding, Majapahit had experienced many ups and downs like other kingdoms or dynasties, the historical dynamics of Majapahit cannot be separated from the various political upheavals at that time. Since Raden Wijaya founded the Majapahit, there had been various rebellions, Especially during the reign of Jayanegara (1309 - 1328 CE) (Djoened & Poesponegoro, 2008; Muljana, 2005; 1976). Regardless of the various rebellions and wars that occurred from its beginning until

Figure 1. Mandala's influence of Majapahit power in the Indonesian archipelago at its heyday in Hayam Wuruk (1350 - 1389 CE) reign (modification from Cribb (2013)).

its collapse, Majapahit is still rembered as an empire with great influence in the archipelago. Its power which was so broad and divided into 14 subordinate regions, indirectly contributes to the formation of Indonesian culture. This can be seen based on the pattern of social, political, and cultural conditions at that time.

However, at the end of Majapahit's heyday, especially after Wikramawardhana's rule (1389–1429 CE), Majapahit was overwhelmed by Paregreg civil war between the royal families (1405 - 1406 CE). This war made Majapahit lose some of its subordinate areas. In addition, the rapid spread of Islam, accompanied by the emergence of Islamic kingdoms, made Majapahit increasingly lose prestige. As a result of prolonged internal royal conflicts and the Islamization process experienced massive and systematic developments, over time, Majapahit completely collapsed. Many historians have studied and put it forward regarding the collapse of Majapahit (Noorduyn, 1978; Muljana, 2005; Djafar, 2009; Rahardjo et al., 2011). Some of them argued that the beginning of the collapse of Majapahit occurred in 1478 CE. This is based on a chronogram or *candrasengkala*, or in other words: *sirna ilang kretaning bhumi*, which means the prosperity of the earth will disappear. According to many historians, this *candrasengkala* is a depiction of the beginning of the collapse of Majapahit (Muljana, 1976; Djoened & Poesponegoro, 2008; Muljana, 2005).

Apart from differences of opinion regarding exactly when the Majapahit collapsed, the events of collapse of Majapahit were at least preceded by several important events. These events included civil wars between royal families, the loss of central power outside the area around the capital city of Majapahit, and the spread of Islam, which had grown rapidly in Malacca since the 1400s and was followed by the emergence of Islamic sultanates, which then challenged Majapahit sovereignty. When Islam entered and developed rapidly in Samudra Pasai and Malacca, many Majapahit residents who lived on the coast converted to Islam. This is because north coast of Java (*Pantura Jawa*), apart from being a meeting place for various cultures, also received less monitoring from the kingdom's center (Ricklefs, 2008). Muljana (2005) argues that many of the coastal residents who embraced Islam resulted in the growth of immigrant and Islamic villages. The existence of the new village displaced the economic lifeblood in Majapahit. The economy in coastal areas slowly shifted into the hands of immigrants. This influenced the process of the destruction of Majapahit. Along with the disappearance of Majapahit's prestige, the big cities in the coastal areas were controlled by Muslim traders. The merchants then brought new trading ports that could compete with trading ports from Majapahit.

For example, an area called Bintara, or Demak, was one of the coastal areas which was a tough competitor for the Majapahit trade port (Muljana, 1976). Many traders from various countries gathered in Demak to trade, then settled there and spread Islam in the area. During the reign of Kertabhumi (1468 - 1474 CE), Demak was led by a duke who was a Muslim, namely Raden Patah. Raden Patah was the son of Kertabhumi from a Chinese wife whom Arya Damar raised. In the future, Demak, under Raden Patah, became a fairly advanced area and was known by traders from within and outside the archipelago. In its development, the Muslims living in Demak were united by Raden Patah and succeeded in becoming a major force for the Duchy of Demak. These powers include the military, bureaucratic government, and the economy. This great power then became the capital for Demak to escape from the clutches of Majapahit. In subsequent developments, Demak, which received assistance from coastal areas such as Jepara, Surabaya, Kudus, and Banten, openly separated itself from Majapahit. In 1478 CE, Demak became an independent Islamic sultanate. Its first sultan was Raden Patah, who had the title *Sultan Akbar Al-Fattah*. For about three years, Raden Patah had made extraordinary achievements. The sultan and his followers managed to control Semarang. In 1517 CE, Demak invaded Majapahit and succeeded in severing the relationship between Majapahit and the Portuguese. In the next attack in 1527 CE, Demak succeeded in eliminating Majapahit from the Indonesian archipelago (Muljana, 2005; Ricklefs, 2008).

Apart from the effects of political turmoil and the arrival of Islam which caused the direct cause of the destruction of Majapahit, it is interesting to examine environmental causes, which may also have contributed indirectly to this event. This is interesting because the territory controlled by Majapahit, namely the Indonesian archipelago, is an area that is prone to natural disasters, such as floods, landslides, volcanoes, earthquakes, and droughts regularly (Wardani & Kodoatie, 2008). Unfortunately, only a few studies have examined this topic. The only study that takes this issue seriously is a regional geological study conducted by Satyana (2007) which discusses the possible contribution of mud volcano eruptions near the capital city of Majapahit, which may have contributed to the period of the fall of this empire. Though this is necessary to reconstruct the environmental history of Majapahit from a holistic point of view.

This study attempts to answer this challenge by taking a statistical approach to drought conditions in Indonesian archipelago during the Majapahit era. These hydroclimatological parameters were chosen because it influenced the collapse and birth of various classical world civilizations (e.g. DeMenocal, 2001; Shen et al., 2007; Zhang et al., 2008; Buckley et al., 2010; Fleitmann et al., 2022). This study presents the statistical analysis of hydroclimate estimations from Paleo Hydrodynamics Data Assimilation product (PHYDA) (Steiger et al., 2018) over the Indonesian archipelago during the Majapahit reign. Considering that

the Mandala of Majapahit covers almost the entire Indonesian archipelago, for this study, we took the scope of hydroclimatology area in the Southeast Asian archipelago. The Southeast Asian archipelago is better known hydroclimatologically as the Maritime Continent (MC) (Ramage, 1968). The hydroclimatological cycle in the MC, located between the tropical Indian and Pacific oceans, is regulated by the annual Asia-Australia monsoon (AAM) cycle (Aldrian & Susanto, 2003; Neale & Slingo, 2003; Chang et al., 2005; Robertson et al., 2011; Yamanaka, 2016; Yang et al., 2019). This latitudinal cycle of annual displacement of the Intertropical Convergence Zone (ITCZ) is characterized by a northwesterly movement that brings moist air from Asia to Australia during boreal winter and a southeasterly movement that brings dry air from Australia to Asia during the boreal summer. This annual cycle causes the wet season in December - January - February (DJF) and the dry season in June - July - August (JJA) over the MC (Chang et al., 2005). In addition to the annual cycle, the MC is also affected by the interannual quasi-periodic oscillation in the tropical Pacific known as the El Niño Southern Oscillation (ENSO) (Aldrian & Susanto, 2003; Robertson et al., 2011; Yoden et al., 2017). During the El Niño phase, Sea Surface Temperatures (SST) cooling anomalies occur, and the Walker circulation weakens, which results in a decrease in the convection process that occurs in the MC. Conversely, during the La Niña phase, there is an anomaly of an increase in SST and a strengthening of the Walker circulation, which increases the convection process in this region. This El Niño phase can also extend the dry season and cause drought over the MC (Hendon, 2003). Because this study only discusses the effect of droughts on the political dynamics, we limit our study to the dry season (JJA). This boreal summer periods was chosen because of the strong ENSO influence in that season (Robertson et al., 2011).

Data and Methods

Data

We used three hydroclimatological reconstructions mean parameters from PHYDA, as follows, annual West Pacific ITCZ index (WP ITCZ), monthly Niño 3.4 SST, and annual Palmer Drought Severity Index (PDSI) to determine drought and hydroclimatological conditions in the Majapahit region. We used PHYDA datasets because they are the best estimate of the fusion between the Community Earth System Model Last Millennium Ensemble (CESM LME) of climate model simulations (Otto-Bliesner et al., 2016) and 2,978 annually-resolved proxy series using data assimilation techniques (Bhend et al., 2012; Goosse et al., 2012; Steiger et al., 2014; Hakim et al., 2016; Franke et al., 2017; Steiger et al., 2018), which are expected to be able to describe hydroclimate conditions over the MC during the Majapahit era. Furthermore, the methodology employed in PHYDA encapsulates advancements and refinements drawn from its predecessor reanalysis product, specifically referred to as the Last Millennium Reconstruction (LMR) (Steiger et al., 2018). Notably, the reconstructed PDSI outcomes within the PHYDA framework exhibit noteworthy correlations of significance not only with the LMR product but also with the Monsoon Asia Drought Atlas (MADA) over the MC (Steiger et al., 2018; Roldán-Gómez et al., 2023)

We truncated the spatial data. This 2° × 2° horizontal resolution on the Maritim Continent grids (20°S - 20°N, 90° - 160°E) and during the Majapahit era (1293 - 1527 CE). We divided the data analysis into two sections: spatial analysis and temporal analysis.

Spatial analysis

We conducted the spatial analysis by calculating the PDSI anomaly analysis at each stage of the political conditions in Majapahit. We calculated the drought anomalies according to six significant events in the political history of Majapahit: during the reign of Jayanegara, which was marked by many rebellions (1309 - 1328 CE), during the heyday of the Majapahit under the leadership of Hayam Wuruk (1350 - 1389 CE), during the Paregreg war (1405 - 1406 CE), in 1426 CE, which was marked by the great famine (Krom, 1926; Noorduyn, 1978), in 1478 CE, which is believed to be a significant year at the beginning of the fall of the Majapahit (*candrasengkala*) (Djoened & Poesponegoro, 2008; Djafar, 2009; Ricklefs, 2008; Ricklefs et al., 2010), and in 1527 CE which is believed to be the last year of Majapahit before being completely conquered by Demak. These anomalies were calculated by subtracting the temporal average of PDSI at each stage against the entire Majapahit era as a reference period (1293 - 1527 CE). We calculated the average from the previous year and the following year, especially concerning the events of the great famine, *candrasengkala*, and the final year of Majapahit. This was done because each of these events lasted only one year. We used the average values to mitigate the drought lag caused by the PDSI calculation, which took several months. There was concern that if we had only taken the PDSI value for each year of occurrence, we would not have been able to capture rapidly changing drought situations (Alley, 1984). Then these spatial anomalies were displayed visually and compared with the existing historical literature. Calculation and visualization of these anomalies were done using

the xarray (Hoyer & Hamman, 2017) and Cartopy (Met Office, 2015) libraries in the Python computing environment.

In addition to visually inspecting spatial PDSI anomalies, we also conducted the Mann-Whitney U test (Mann & Whitney, 1947) to test whether the PDSI in each grid in each of the six crucial episodes in the history of Majapahit have statistically significant differences from the PDSI in each grid throughout the reference period (1293 - 1527 CE). We employed the Mann-Whitney U test because it is a non-parametric test that does not assume that the samples in the two groups are drawn from a normal distribution (Wilks, 2011). The null hypothesis is that the sum of the rankings in the two groups does not differ. Meanwhile, for the alternative hypothesis, in the population, the sum of the rankings differs in the two groups. This test was performed by calculating the U statistics for each group (in the context of this study, the U statistics of the six critical episodes in the history of Majapahit, U_x and the reference period, U_y),

$$U_x = mn + \frac{m(m+1)}{2} - R_x \tag{1}$$

$$U_y = mn + \frac{m(m+1)}{2} - R_y \tag{2}$$

Then we calculated U statistics for both of these groups,

$$U = min(U_x, U_y) \tag{3}$$

, where m is the number of samples drawn from population X, n is the number of samples drawn from population Y, R_X is the sum of ranks of population X, and R_Y is the sum of ranks of population Y. The p-value was calculated based on comparing the critical and U values. If the U value is less than or equal to the critical value, we reject the null hypothesis and vice versa. Because the number of PHYDA grids in the MC are large enough ($n > 20$), the p-value was calculated based on the normal approximation using standardized test statistics (Wilks, 2011). We used the statistics module in the SciPy library in the Python computing environment to perform the Mann-Whitney U test (Virtanen et al., 2020).

Temporal Analysis

Niño 3.4 differs from the other two, we took the annual average on this time series. Then we spatially averaged the PDSI data over the MC, so we got a single time series. We use the xarray library (Hoyer & Hamman, 2017) in the Python computing environment to retrieve this spatially averaged PDSI. We did not preprocess the ITCZ data because it represents the convective regime in the Indo-Pacific Warm Pool (IPWP). Finally, we made a graphical alignment (Prell et al., 1986; Lisiecki and Raymo, 2005) of these three hydroclimatic parameters using the Pyleoclim library (Khider et al., 2022) in the Python computing environment.

We used Pearson's correlation (Pearson, 1895) to calculate the relationship between time series: WP ITCZ - PDSI, Niño 3.4 SST - PDSI, and WP ITCZ - Niño 3.4 SST. The correlation value is determined through the following equation,

$$r = \frac{\sum_{i=1}^{n} (x_i - \underline{x})(y_i - \underline{y})}{\sqrt{\sum_{i=1}^{n} (x_i - \underline{x})^2 (y_i - \underline{y})^2}} \tag{4}$$

, where n is the length of time that Majapahit was in power (234 years), x_i and y_i are respectively the first and second time series values at time i, and and are the average values of the first and second time series, respectively. We used Student's t-test to determine the confidence interval. This calculation was done automatically using the Pyleoclim library in the Python computing environment (Khider et al., 2022).

Results and Discussion

PDSI and PDSI spatial anomalies of each PHYDA grid during the reign of Jayanegara (1308 – 1328 CE) are shown in the Figure 2 and Figure 3c, respectively. It appears during this period were negative anomalies in almost the entire PHYDA grid over the MC. This difference was further confirmed by U statistics of the two-sided Mann-Whitney test of 8235 with a p-value < 0.01. This pattern is also seen in the negative values of the spatially averaged time series of PDSI over the MC in this period (Figure 4, bottom panel). It could be stated that there was a widespread and prolonged drought over the MC region during the his reign.

After ascending the throne, Jayanegara was titled *Sri Sundarapandya Dewa Adhiswara Wikramatung-gadewa*. His life story was written in several records, such as *Pararaton* and *Nagarakretagama* (Djoened & Poesponegoro, 2008). From *Pararaton*, it was known that Jayanegara had the nickname *Kala Gemet*. This nickname was pinned because the king had a personality that was not good and was considered weak as a ruler (Djoened & Poesponegoro, 2008). The reason is, during the time of Jayanegara, the Majapahit often experienced rebellions. For example, the Gajah Biru Rebellion (1314 CE), the Nambi Rebellion (1316 CE), the Semi Rebellion (1318 CE), and the Kuti Re-

bellion (1319 CE) (Ricklefs, 2008; Ricklefs et al., 2010). The series of rebellions occurred due to slander by Mahapati, a cunning palace official. Jayanegara's life barely survived when the Kuti Rebellion broke out because the royal capital was captured (Djoened & Poesponegoro, 2008; Muljana, 1976; 2005). Jayanegara managed to survive the series of rebellions that hit the kingdom during his reign due to Gajah Mada's role as commander of *Bhayangkara* (an elite secret service unit of Majapahit). Although after the Kuti Rebellion his government gradually improved, the disappointment of the palace officials with his attitude could not be eliminated. In 1328 CE, Jayanegara died after being stabbed by Ra Tanca, a member of *Dharmaputra* (a special group of employee loved by the king) who also acted as a royal physician (Djoened & Poesponegoro, 2008; Muljana, 1976; 2005). However, no records and historical studies that discuss drought in that period. We can only speculate if the drought may have been one of many factors in this political instability.

PDSI and PDSI spatial anomalies of each PHYDA grid during the heyday of Majapahit under Hayam Wuruk as a king and Gajah Mada as a prime minister (1350 - 1389 CE), are shown in the Figure 2 and Figure 3b, respectively. On average, during this period, there was no widespread distribution of extreme PDSI anomalies over the MC (Figure 3b). This is also evident from a relatively periodic oscillation of the spatially averaged time series of PDSI over the MC in this period (Figure 4, bottom panel). This hydroclimatological stability was also confirmed by the value of the two-sided Mann-Whitney U test on the spatial PDSI distribution (Figure 2) of 24346. Still, with a p-value > 0.01, it can be concluded that in this period, there was no statistically significant difference in PDSI compared to the reference period.

Hayam Wuruk ruled Majapahit for 39 years. He ascended the throne at a young age, when he was 16 years old, and became the fourth king to replace Tribhuwana Tunggadewi. During his leadership, Hayam Wuruk was accompanied by a prime minister named Gadjah Mada. Hayam Wuruk then married the daughter of Wijayarajasa (*Bhre Wengker*), named Sri Sudewi, with the title *Paduka Sori*. Hayam Wuruk had a daughter named Kusumawardhani, who married Wikramawardhana (the fifth king of Majapahit) (Djoened & Poesponegoro, 2008; Muljana, 1976; Ricklefs, 2008; 2010).

During his reign, Hayam Wuruk was touted as the greatest Majapahit king. His success in bringing Majapahit to the pinnacle of glory could not have been separated from the help of Gajah Mada. When Hayam Wuruk and Gajah Mada were running the government, the entire Indonesian archipelago and even the Malacca Peninsula were flying the Majapahit banner. The *Palapa* Oath declared by Gajah Mada was carried out, with Majapahit's territory covering Sumatra, the Malay Peninsula, Kalimantan, Sulawesi, the Nusa Tenggara Islands, Maluku, Papua, Tumasik (Singapore), and parts of the Philippine Islands (Djoened & Poesponegoro, 2008; Rahardjo et al., 2011; Ricklefs, 2008; Ricklefs et al., 2010). In addition, this kingdom has relations with Campa (southern Vietnam), Cambodia, Siam (Thailand), southern Burma, Vietnam and China. Majapahit also has a formidable navy fleet un-

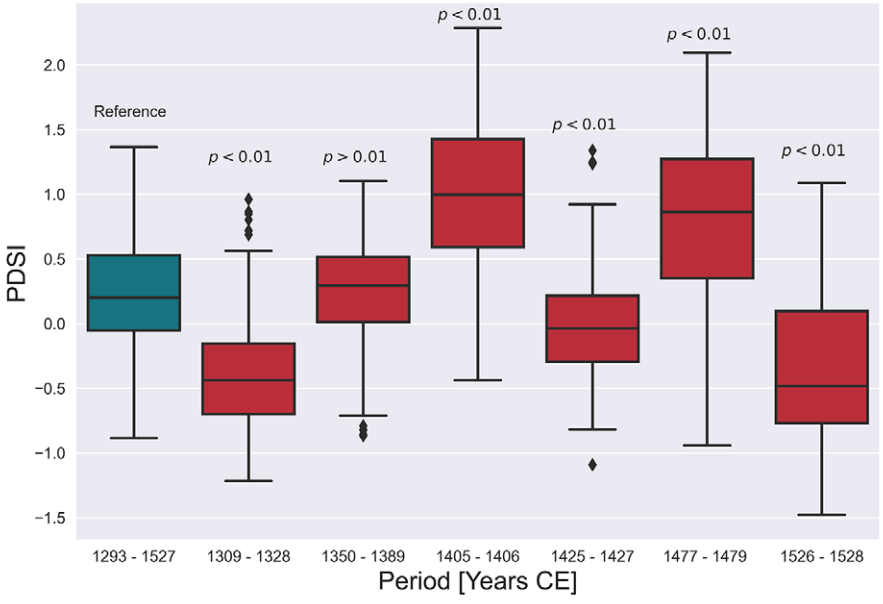

Figure 2. Boxplots depict the distribution of average PDSI values in each grid during crucial periods in Majapahit history (red) and reference periods throughout Majapahit history (blue). The center line within each box indicates the median value, while the lines at the top and bottom represent the upper and lower quartiles. Points beyond the minimum and maximum lines on the whiskers indicate extreme values

der the leadership of Mpu Nala. With its military strength and strategy, Majapahit was able to create stability in its territory. Meanwhile, in the economy, Majapahit became a trade center in Southeast Asia with export commodities consisting of pepper, salt and cloth (Djoened & Poesponegoro, 2008; Rahardjo et al., 2011; Ricklefs, 2008; 2010). Since there are no conclusive historical studies about the effect of drought on Majapahit's heyday, we can only speculate that the relatively stable hydroclimatic regime at that time may have contributed to the political and economic stability that allowed Majapahit to expand its influence.

After reaching its peak in the 14th century, Majapahit's power gradually weakened. After the death of Hayam Wuruk in 1389 CE, Majapahit entered a period of decline, one of which was the result of a conflict over the throne. Hayam Wuruk had been succeeded by the crown Princess Kusumawardhani, who had married a relative, Prince Wikramawardhana. Hayam Wuruk also had a son by his mistress, Wirabhumi, who claimed his right to the throne. Finally, the first civil war emerged, often called the Paregreg war, estimated to have occurred in 1405 - 1406 CE between Wirabhumi and Wikramawardhana (Muljana, 1976; 2005; Djafar, 2009). Wikramawardhana finally won this war. This civil war weakened Majapahit's control over its conquered areas on the other side. Twenty years after this war, there was a great famine event (1426 CE) that was considered to weakened the Majapahit government's authority (Krom, 1926; Noorduyn, 1978).

During the reign of Wikramawardhana, a series of Ming Dynasty maritime expeditions led by Admiral Zheng He, a Chinese Muslim admiral, arrived in Java several times between 1405 CE to 1433 CE (Ricklefs, 2008; 2010). Since 1430 CE, Zheng He's expedition created Chinese and Arab Muslim communities in several port cities on the north coast of Java, such as Semarang, Demak, Tuban, and Ampel (Muljana, 1976; 2005; Djoened & Poesponegoro, 2008). Islam began to have a foothold on the north coast of Java. During the middle of Majapahit's reign, Muslim traders and religious preachers started to enter the Indonesian archipelago.

PDSI and PDSI spatial anomalies of each PHYDA grid during the crucial episodes during the reign of Wikramawardhana, are shown in the Figure 2 and Figure 3, respectively. During the Paregreg War, there were relatively wet events

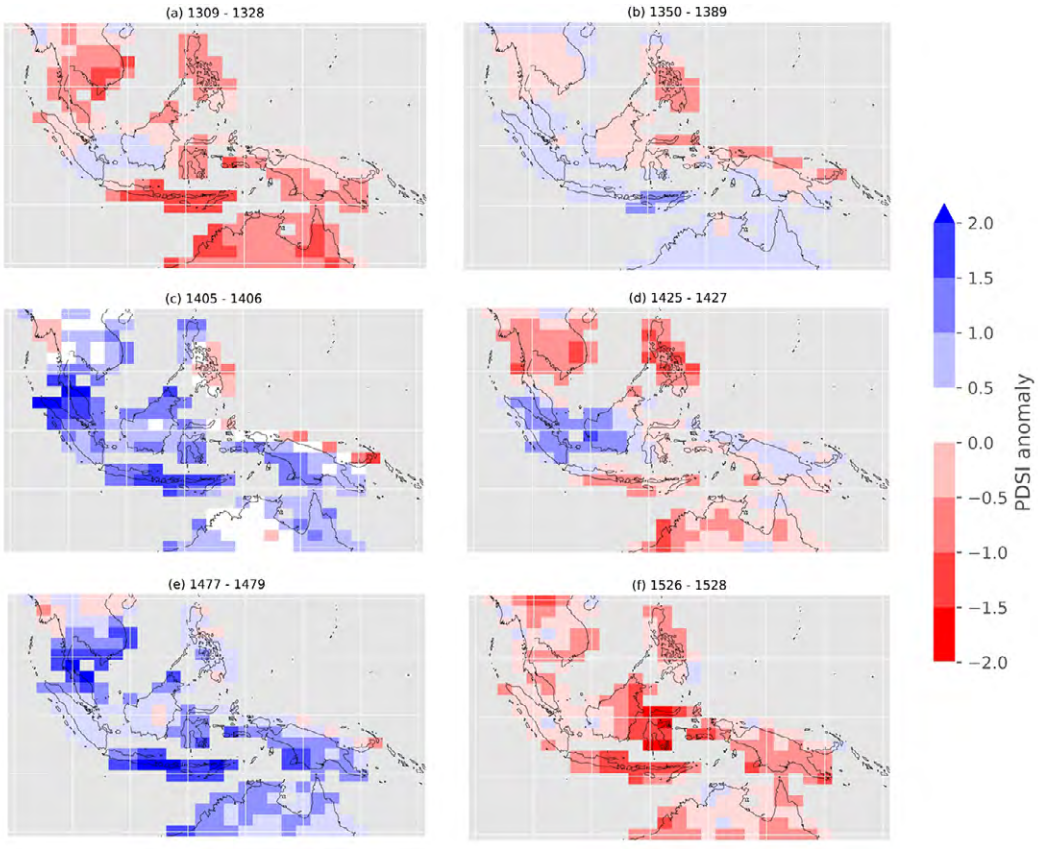

Figure 3. Spatial representation of PDSI anomalies over the MC during the six critical episodes in the history of Majapahit: (a) the reign of Jayanegara (1309 - 1328 CE), (b) the reign of Hayam Wuruk (1350 - 1389 CE), (c) Paregreg War (1405 - 1406 CE), (d) the great famine event (1427 - 1428 CE), (e) the *candrasengkala* event; which marked the beginning of the collapse of the Majapahit (1477 - 1479 CE), and (f) the final year of Majapahit (1526 - 1528 CE). All values shown refer to anomalies from the Majapahit era (1293 - 1527 CE)

in JJA, which can be seen in its spatial (Figure 3c) and temporal observations (Figure 4, bottom panel). The statistical significance was also confirmed by the value of the two-sided Mann-Whitney U test on the spatial PDSI distribution (Figure 2) of 39713 with a p-value < 0.01. Meanwhile, during the great famine event in 1426 CE, there was a drought event over the MC (Figure 3d). It was also confirmed by the Mann-Whitney U test value of 11600 for the reference period in the spatial PDSI distribution with a p-value < 0.01. As with other significant events in the Majapahit era, until now, research has yet to be conducted that specifically discusses droughts or floods during this period. We can only speculate that the hydroclimatic regime influenced two important events in this period.

In the late 14th and early 15th centuries, Majapahit influence throughout the archipelago began to wane. At the same time, a new trading empire based on Islam, namely the Malacca sultanate, started to emerge in the western part of the archipelago. In the western part of this empire that was beginning to collapse, Majapahit was powerless again, stemming the rise of the Malacca Sultanate, which in the mid-15th century began to control the strait of Malacca and spread its power to the island of Java and many preachers were sent or came voluntarily to this area for Islamization, both internal and external Islamization, one of which was Sheikh Maulana Ishaq, Sunan Giri's father, who became a preacher in Blambangan, on the north coast of East Java, at the far east (Muljana, 1976; 2005; Djoened & Poesponegoro, 2008; Ricklefs, 2008; 2010). Meanwhile, several colonies and areas conquered by Majapahit in other regions in the archipelago, one by one, began to break away from Majapahit rule.

Not only Malacca after that but there was also the first Islamic kingdom in Java, namely Demak, which Raden Patah founded. In subsequent developments, Demak openly broke away from Majapahit. This success, of course, must be supported by the assistance of coastal areas, such as Jepara, Surabaya, Kudus and Banten. Demak became an independent Islamic sultanate; with its first king Raden Patah, the fall of Majapahit could not be separated from Demak's participation. It is because one of the causes of the collapse of Majapahit was the intervention of Demak. This event led to changes; the people of Majapahit, who were originally Hindu-Buddhist, converted to Islam, especially with the people on the north coast of Java. Second, there is a mixture of Javanese culture and Islam. The third is the shift of Hindu-Buddhist power to an Islamic power system. According to the *Kandha* text and the Islamic chronicle, written later and according to the story, the events of the capture of the capital city of Majapahit by the Muslims in 1527 CE (Muljana, 1976; 2005; Djoened & Poesponegoro, 2008; Ricklefs, 2008; 2010).

There were two significant events during this period: the *candrasengkala* event in 1478 CE and the overall conquest of Majapahit by Demak in 1527 CE. This *candrasengkala* event was marked by an attack from another Hindu

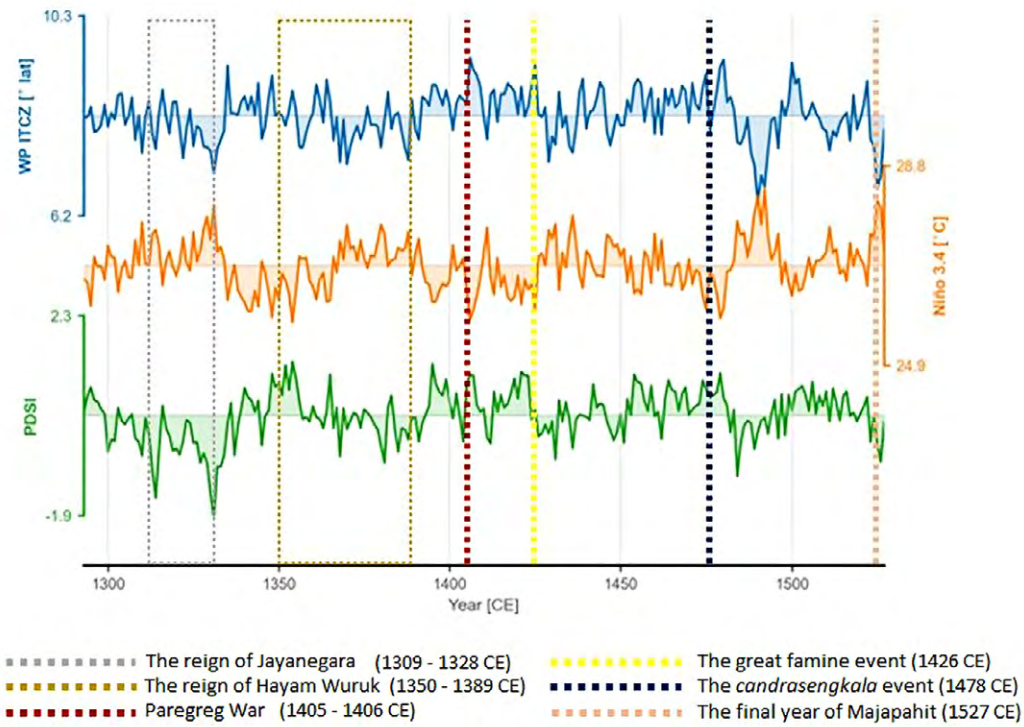

Figure 4. Hydroclimatological parameters used to identify drought during the Majapahit period from PHYDA. The top panel shows the West Pacific ITCZ in degree latitude. The middle panel shows Niño 3.4 SST (°C). The bottom panel shows the spatially averaged time series of PDSI over the MC

kingdom, namely the Kingdom of Kediri, with its king Girindrawarddhana Dyah Ranawijaya. At that time, the king of Majapahit was Kertabhumi. The attack resulted in the death of the Majapahit king in his palace (Djafar, 2009). The birth of the Demak sultanate also occurred in this year (Muljana, 1976; 2005; Djoened & Poesponegoro, 2008; Ricklefs, 2008; 2010). Hydroclimatologically, during the JJA season in 1478 CE, there was a wetter event than the reference period (Figure 3e and Figure 4). Statistically, this is also considered significant because the two-sided Mann-Whitney U test results on the spatial PDSI distribution (Figure 2) are 34699 with a p–value < 0.01.

In 1527, the Demak army, led by Sultan Trenggana, under the leadership of Sunan Kudus, succeeded in ultimately conquering Majapahit (Djoened & Poesponegoro, 2008; Ricklefs, 2008; 2010). This event became the end of the existence of Majapahit. At the time of this incident, there was a drought over the MC during the boreal summer (Figure 3f and Figure 4). The difference in the spatial PDSI distribution (Figure 2) in this year against the reference period is 10453, with a p-value < 0.01. So, the MC drought during the Majapahit conquest by Demak was statistically significant. The hydroclimatological records of these two important events at the end of Majapahit have not been studied by historians. So we can only speculate that the hydroclimatological conditions at that time might have contributed to the end of Majapahit rule.

The WP ITCZ in JJA (Figure 4, top panel) has a positive correlation with the spatially averaged time series of PDSI over the MC (Figure 4, bottom panel) with a value of 0.590 (p-value < 0.01). Meanwhile, Niño 3.4 SST has a negative correlation (Figure 4, middle panel) with the spatially averaged time series of PDSI over the MC of -0.715 (p-value < 0.01). Meanwhile, WP ITCZ negatively correlates with Niño 3.4 SST of -0.876 (p-value < 0.01). It supports the notion that the southward shift of the ITCZ weakens trade winds across the tropical Pacific which could initiate an El Niño-like response via Bjerknes feedback. In the end, this is what causes drought over the MC (Bjerknes, 1969; Pausata et al., 2020).

Concluding Remarks

This study shows that there were changes in the hydroclimatological regime over the MC in almost every important episode in the history of Majapahit. This change is also statistically significant. This change in hydroclimatological conditions may be caused by a shift in the ITCZ and the ENSO phase.

However, the coincidence of these changes cannot necessarily be said to be the cause of several events of political upheavals in Majapahit. Six things are the limitations of this study:

- This is an exaggerated simplification of the relationship between the complexity of socio-political problems during the Majapahit era and the hydroclimatological regime at that time (Haldon et al., 2018).
- Limitations on proxy records over the MC at that time certainly limited the accuracy of PHYDA in reconstructing the PDSI.
- This study is only limited to the hydroclimate conditions during the boreal summer; of course, analysis is needed in other seasons to view the hydroclimatic conditions comprehensively.
- This study is only based on the mean state of the PDSI reconstruction at PHYDA; of course, we cannot deny the standard deviation of the Ensemble Kalman filtering results from the data assimilation process that was established (Evensen, 2009).
- This study is only based on secondary historical literature, which did not record the drought at Majapahit's time. In ancient Javanese texts, there is ambiguity in the writing of natural disaster events which confuses facts and fiction (Sastrawan, 2022), so historians and philologists need particular intention and expertise to extract primary sources which are generally written in Sanskrit or ancient Javanese.
- A more in-depth study is needed on the dynamics of ITCZ - ENSO in influencing drought over the MC during the Majapahit period. It is necessary to consider that the historical events of Majapahit occurred in the shift from Medieval Climate Anomaly (MCA) (950 - 1250 CE) to Little Ice Age (1450 - 1850 CE) which made it possible for the ITCZ to shift in that period (Roldán-Gómez et al., 2022).
- Apart from these six shortcomings, this study has shown a correlation between hydroclimatological conditions over the MC controlled by ENSO and ITCZ, which may play a role in the political events in Majapahit. Historical research based on primary literature, archaeological research on Majapahit heritage sites, and paleoclimate observations with high-resolution proxies in the MC are needed to reveal the role of hydroclimatological conditions in the history of Majapahit in greater depth.

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Open Research

PHYDA (Steiger et al., 2018) was accessed via the NOAA/NCEI Paleoclimatology data library at the following URL: https://www.ncei.noaa.gov/access/paleo-search/study/24230. The Python code for producing all figures in this study is available from the GitHub repository: https://github.com/sandyherho/majapahitDrought23.

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Key Factors of Nature-Based Tourism Future Development in Less-Developed Nature Destinations – Case study: Ardabil province of Iran

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KEYWORDS

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ABSTRACT

The study examines key factors influencing nature-based tourism (NBT) development in less-developed nature destinations, selecting Ardabil province of Iran as a case study. It employed a qualitative approach involving fifteen semi-structured interviews and thematic analysis. The study identified seven factors contributing to the development of NBT: tourism development requirements, new managerial initiatives, political support and planning, democratic approach, destination management, sustainability and awareness. The study highlights the importance of sustainability in shaping the future of NBT, which must be considered in policymaking and planning and environmental and climate change impact management. The study recommends knowledge circulation for effective future-based planning. The findings provide valuable insight into the factors required for NBT development at macro and micro levels and can assist DMOs and policymakers of less-developed nature destinations better underrated NBT destination management, allowing them to be better prepared for the future.

Introduction

By creating a symbiotic relationship between tourism and natural areas (Wolf et al., 2019), nature-based tourism (NBT), also known as nature tourism (An et al., 2019) accounts for a large, growing proportion of global tourism (Pickering & Weaver, 2003) with significant economic, socio-cultural, and environmental consequences for host communities (Buckley, 1994). NBT consists of activities based on "consumptive uses, such as recreational hunting and fishing; outdoor recreation and adventure; passive enjoyment of scenery, geology, flora and fauna; and non-consumptive activities for conservation and research" (Wolter, 2014, p. 13). When the setting for tourism activities is nature, specific elements of the natural environment are the reason for tourism flows. Even when tourism is developed to conserve natural areas (Hall & Boyd, 2004), the type of tourism development may be considered

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as NBT. Padma et al. (2022) argued that it could contribute to reducing carbon footprints, energy consumption and climate change if several fundamental factors are considered, including stakeholder empowerment, monitoring the state of nature, economic development of local areas, adopting environmentally friendly solutions and changing stakeholders' mindsets.

NBT is developed and managed by public agencies, private sectors, and NGOs (Pickering & Weaver, 2003) with certain characteristics depending on the nature of the societies. As a subcategory of the tourism system, NBT development is heavily influenced by society's macro natural, socio-cultural, political and economic systems (Hall & Boyd, 2004). Since these factors differ depending on the context in which tourism develops, identifying the specific factors that influence NBT development is critical. Meanwhile, despite recent increases in NBT studies (Hall & Boyd, 2004), to the best of the authors' knowledge, little is known about the various factors that influence its development in less-developed nature destinations, which place economically significant value on environmental resources upon which tourism depends (Dixon et al., 2001) and where natural heritage is often traded for economic gain (Larrán et al., 2015). Therefore, it is important to investigate what contributes to or hinders NBT in contexts where development plans (including tourism) degrade environmental resources mainly because of economic dilemmas and poor management (Shahbaz et al., 2021). In this regard, this study aims to identify the key elements influencing the development of NBT in the Ardabil province of Iran.

Tourism development in Ardabil has received considerable attention in recent years, ranging from government investments in developing tourism projects (MENAFN, 2020) to authorities planning to transform Ardebil into a winter tourism destination (Tehran Times, 2020) and the selection of the province as the OECD tourism capital in 2030 (Mehr News Agency, 2019). Despite its potential, the province of Ardabil is still not regarded as one of Iran's top tourist destinations. Recent statistics show that the annual number of Iranian visitors to Ardabil is less than three million, in contrast to the Province of Guilan, which received over ten million tourist arrivals as one of the top Iranian tourist destinations (Statistic Center of Iran, 2018). According to Rahmani et al. (2010, 2012), Tavakoli et al. (2014) and Varesi et al. (2012) Ardabil can be regarded as a nature destination, with a solid potential to attract tourists in different seasons because of its natural attractiveness and varied climate (Jafari & Salmani, 2018). However, despite the potential for NBT development in this destination, several factors influence the development process in the future and identification of these factors is the main objective of this study. This is particularly significant in less-developed countries with less diverse economies, as NBT may warrant special attention in such contexts (Tisdell, 2013).

This study makes a two-fold contribution. It provides a theoretical discussion of the understating of NBT development within less-developed nature destinations, with a specific focus on the Ardabil province of Iran and expands current knowledge in this important area of tourism literature. By examining the key factors that influence NBT development in such contexts, this study aims to provide valuable insight into the complex dynamics that shape sustainability development. The findings may provide practitioners with an informative perspective from which to comprehend the factors influencing the evolution of NBT. These insights can potentially play a crucial role in promoting the sustainable development of nature destinations. Particularly in the case of Iran, implementing sustainable solutions and long-term ecologically sound strategies is essential. These measures are necessary to address the multifaceted challenges arising from the destruction of biodiversity (Makian & Hanifezadeh, 2021).

Literature review

Nature-based tourism development

Rooted in the post-Fordism dialectic and the environmental movement since 1980 (Arnegger et al., 2010), NBT concept is used to describe tourism activities based on natural resources (including landscape, topography, vegetation, wildlife, etc.) that remain relatively undeveloped (Yıldırım et al., 2008). Individuals benefit from natural attractions for spiritual and physical richness, cognitive development, leisure, environmental awareness, and esthetic experiences (Teles da Mota & Pickering, 2021). Fossgard & Fredman (2019) conceptualized NBT as an intersection between tourism, outdoor recreational activities and natural resources. Economically, it is a significant part of the growing tourism sector (Arnegger et al., 2010; Fossgard & Fredman, 2019). According to the Center for Responsible Travel (2018) report, NBT accounts for approximately 20% of all types of tourism globally, and this share is continuously increasing (Metin, 2019). This is likely because this broad concept includes ecotourism, adventure tourism, sustainable tourism, and cultural tourism (Roxana, 2012). Although not the focus of this study, several researchers (Buckley, 1994; Nyaupane, 2007) believed that these terms are interchangeable; however, ecotourism and NBT concepts (Hall & Boyd, 2004) have significant differences in quality and responsibility.

Newsome et al. (2002) categorized ecotourism as one of the NBT types with the highest level of sustainability. Consequently, "different points of view of the definitions

for NBT might be the consideration of experience, motivation, and attraction" (Metin, 2019, p. 178). Despite potentially negatively impacting natural resources (An et al., 2019) NBT is more compatible with the environment than mass tourism (Holden, 2003). As Kim et al. (2020) stated, it contributes to biodiversity conservation by providing financial stability and enhancing visitors' interest in nature. The development of NBT relies heavily on the natural environment and numerous multidisciplinary factors (Zhang & Chan, 2016). Additionally, planning and management of NBT have been influenced by the paradigm of sustainability (Pickering & Weaver, 2003).

NBT development in developed and less developed destinations

Regarding the factors affecting NBT's development, Yıldırım et al. (2008) focused on conservation and adequate management, improving infrastructure and transportation networks, determining the carrying capacities, the cultural aspects of communities, and the sustainable use of natural-cultural resources. Considering the importance of the last-mentioned factor and focusing on the complexity of the sustainability approaches of actors in NBT, Sørensen & Grindsted (2021) argued how different actors' sustainability orientations and priorities can limit the tourism development in natural parks. They also emphasize the importance of destination management organizations in recognizing development limitations. In light of the conflict between environmental concerns and business interests between various stakeholders, destination managers are responsible for implementing sustainable projects to achieve the optimal balance between the sustainability aspects and the involvement of all interested parties (Haid et al., 2021). However, Larrán et al. (2015) identified obstacles to implementing sustainability measures, including reluctance to change, a lack of expertise in sustainability, inadequate support, and limited financial resources.

To promote sustainable NBT activities in Pennsylvania's rural counties, besides highlighting the importance of coordination and partnership between stakeholders, Shafer and Choi (2006) recommend knowledge and resource management. Also, Priskin (2001) emphasized that "the future of NBT is strongly resource-dependent and requires access to high-quality natural environments." Larson and Poudyal (2012) proposed integrating insights from relevant fields into adaptive natural resource management strategies to address current tourism concerns to resolve the ambiguity between resource management goals and strategies within tourism projects in less-developed countries. A successful adaptive management approach relies heavily on stakeholder involvement and collaborative decision-making. It facilitates collective learning among stakeholders (Meszaros, 2015), which is the core of knowledge-sharing and management concepts (Weinberger et al., 2007). According to Ruhanen (2008), a fundamental shift in the public sector of tourism toward knowledge management is essential. Education, guides, instructional materials, and models of successful practices can overcome barriers to knowledge access, allowing tourism to achieve long-term development objectives.

Several studies have focused on how tourists contribute to NBT development. Araújo (2017) believed that the success of NBT depends on the effectiveness of environmental education and tourists' satisfaction. As such, Lee and Jan (2018) recommended that NBT destination managers provide plans focusing on nature experiences, increasing tourists' behavior intentions and environmental attitudes. Fernandes (2011) also confirmed that a lack of knowledge of tourist behavior leads to adverse ecological impacts in NBT destinations. Based on cognitive dissonance, Orams (1995) named interpretation an education-based management strategy to minimize tourism pressure on environmental resources. The spatial and temporal distribution of different activities in these areas is the managerial suggestion of Teles da Mota and Pickering (2021). Moreover, Fossgard and Fredman (2019) categorized the multifaceted aspects of NBT development factors such as adapting to guests' needs, availability of resources, facilitating nature experiences, risk management, crowd management, and connections to the place.

NBT development generally requires specific situations and circumstances in most third-world countries. One of the main obstacles in emerging economies is centralized decision-making and planning controlled by the government (Larson & Poudyal, 2012). Also, as Reid & Schwab (2006) stated, obtaining legitimacy for innovative projects that demand an alternative political strategy is challenging and time-consuming in this context. Describing the weaknesses of the tourism planning process in less-developed countries, Tosun and Timothy (2001) believed that the participatory approach is an absent factor of NBT planning due to its significance in power and resource sharing. From a broader perspective, Karamustafa (2012) argued that low-income nations are compelled to embrace mass tourism to earn foreign exchange and create employment opportunities; then, implementing sustainable tourism policies may necessitate difficult political decisions because of the economic structure. Yfantidou and Matarazzo (2017) also attributed the failure to adhere to NBT principles in tourism policies to the significant macroeconomic challenges in developing communities.

NBT development may differ between developed and less developed destinations in many aspects. Less developed and developing regions often possess rich natural resources, which grants them a comparative advantage in NBT (OECD, 2008). However, there is a specific concern about the significance of biodiversity preservation in these

nations, and the direct and indirect dependence of conservation on NBT (Coldrey & Turpie, 2020). From an economic perspective, NBT plays diverse roles in developed and less developed destinations. NBT can catalys green growth in developed regions and facilitate sustainable development (Shang et al., 2023). However, in less developed areas, it is seen as a significant source of income for local communities and rural households (Gupta et al., 2023). On the other hand, it may be challenging to achieve sustainability in NBT in less developed destinations that have a top-down regime (Torn, 2007). Meanwhile, developed countries have implemented strategies to diversify their tourism, resulting in the adaptation of infrastructure, policies and management approaches to promote the sustainability of NBT (Mushawemhuka et al., 2022).

While several studies examined the factors influencing NBT, the present study goes beyond merely reiterating previous findings. Ardabil province of Iran serves as an illustration of how this study distinguishes itself by focusing on the specific context of less-developed nature destinations. By looking deeply into this case, this study may reveal nuanced insights that may not have been adequately addressed in prior studies conducted in more general contexts. Identifying, analyzing and interpreting the key influencing factors is essential for developing tailored strategies and targeted interventions to address the challenges and opportunities of NBT inherent to destinations such as Iran.

Study context: Tourism development in Ardabil

Iran offers many natural attractions (Ghorbani et al., 2015). Located in the northwest of Iran (Fig 1) in a cold and mountainous region with a temperate climate (Sobhani et al., 2018), Ardabil province is one of the most promising NBT destinations. It has been among the desired destinations for domestic nature lovers. 47% of the total 8.121.837 visits were made from February to September 2019 from natural attractions in the province of Ardabil (Country Travel Coordination Center, 2019). This province has attracted great attention due to its climatic characteristics and geomorphological conditions, including abundant mineral springs and thermal sources with unique therapeutic properties scattered throughout the province (Hoseinpour & Riyahi, 2018; Jafari & Salmani, 2018).

According to previous studies on Ardabil province (Rahmani et al., 2010; 2018; Sobhani, 2010; Tavakoli et al., 2014; Varesi et al., 2012), it seems that despite its rich history, it is more of a nature-based destination. In addition, policymakers have recognized tourism as the second most important development driver in this province,

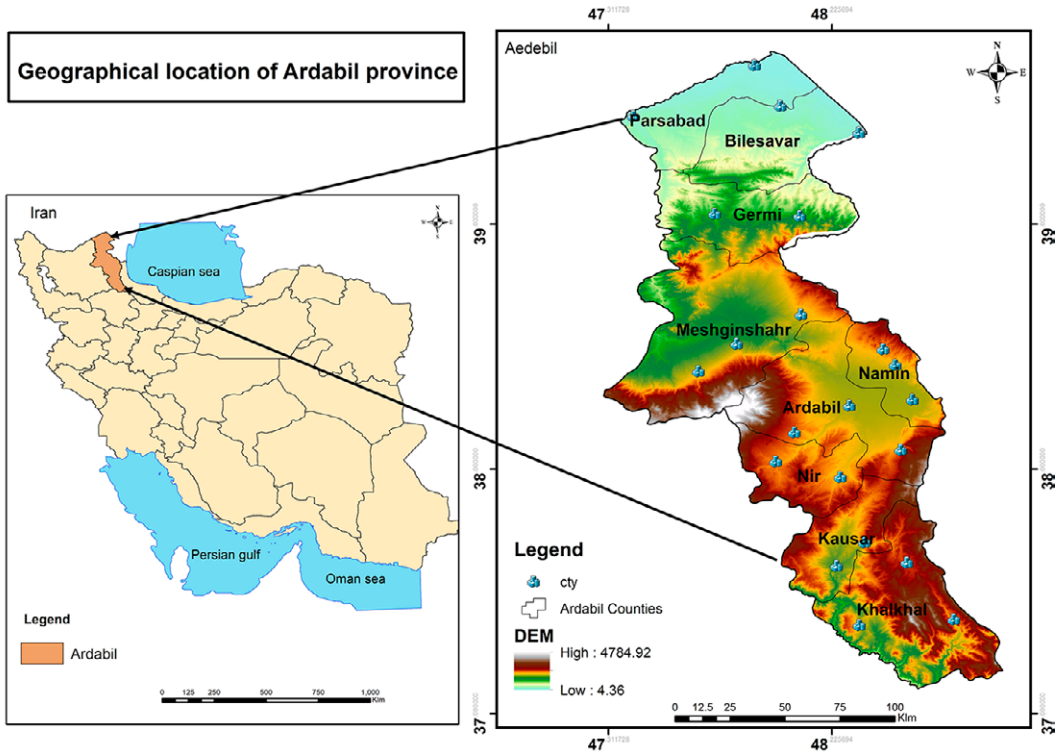

Figure 1. The location of Ardabil province
Source: authors

after agriculture. Despite their natural, economic, social, and cultural potential, rural areas of the province face widespread poverty and rural exclusion (Yarihesar et al., 2016). Ardabil suffers from a lack of tourist facilities despite its real potential. Insufficient information on this destination has left the province isolated and has failed to exploit these resources for tourism development (Varesi et al., 2012).

Methodology

This study used a case study approach to thoroughly examine Ardabil province to comprehend the phenomenon of NBT development and gain insight into how it will develop (Fyall, 2014) to determine factors influencing the future development of NBT. Ardabil province was selected due to its considerable potential for NBT development in Iran. The data were collected through semi-structured interviews during a field trip to Ardabil from August to September 2021. Using purposive sampling, participants were chosen based on their knowledge and activities in the tourism field, specifically NBT in Ardabil. Qualitative research often uses this method to find and select participants with relevant information (Palinkas et al., 2015). The authors included participants in the sample who were believed to be worthy of inclusion (Taherdost, 2016) based on their relevant expertise and experience with NBT and their availability to participate. Table 1 summarizes the participants' characteristics.

The number of interviews was not predetermined. Therefore, data were collected until saturation was reached. Finally, 15 semi-structured interviews were done, and each interview lasted between 30 and 40 minutes. Participants agreed to be interviewed for this study and allowed the recording of interviews, which were then transcribed. The interviews were carried out using an interview guide prepared by the researchers. The questions were open-ended, within predetermined thematic frameworks for identifying the factors influencing the future development of NBT, including the general understating of NBT in the region, future trends shaping its future and existing challenges and opportunities.

One of the authors conducted the interviews and then completely transcribed them. Second, the texts were carefully translated from Persian into English. A qualitative research method was used based on a thematic analysis. An inductive approach was adopted, which involved going line by line through the data and coding paragraphs or segments of text as the concepts evolved (Azungah, 2018). This results in creating categories in a framework that summarizes the primary data and reports the main themes and processes (Thomas, 2006). The data analysis process underwent the following phases: data familiarization; initial code creation; themes scanning; themes review: themes description and naming; and report production (Nowell et al., 2017).

Table 1. Participants' profile

№	Position	Specialties	№	Position	Specialties
P1	Assistant Professor	Tourism geography	P9	Assistant Professor	Geomorphology and NBT
P2	Assistant Professor	Geography, rural planning, and tourism development	P10	Travel agency manager	Cultural and nature-based tours
P3	Expert of Cultural heritage, Tourism and Handicraft Organization	Cultural tourism and NBT development	P11	Environmental NGO Manager	Environment, sustainability and NBT
P4	Tour operator manager	Nature-based tours	P12	Expert of Cultural heritage, Tourism and Handicraft Organization	NBT development
P5	Tour guide	Nature-based tours	P13	Associate Professor	Geomorphology and NBT
P6	Faculty member	Physical geography, climatology, and tourism	P14	NGO manager	Environment and responsible tourism
P7	Professor	Climatology and NBT	P15	Researcher	NBT and ecotourism development
P8	Tour guide	Nature-based tours			

To familiarize themselves with the text, the authors carefully read the transcripts and individually performed the initial coding according to the research objective. During four two-hour online sessions, the authors closely examined and discussed the initial codes to reach a consensus, identify concepts and finalize the themes. Subsequently, the authors reviewed the themes and interpreted the findings. Four experts from the participants reviewed the results and suggested revisions to increase the credibility of the findings. Additionally, direct quotations were cited as allowing the reader to enter the described situation, which is viewed as a validation process (Eldh et al., 2020).

Findings

The results of the thematic analysis are presented in Table 2. During the review of codes, the authors decided to exclude the general factors influencing tourism in Iran, such as international relations and infrastructure, because this study focuses on developing a specific type of tourism (NBT). After several steps of merging the raw codes, we arrived at 51 initial codes and 18 concepts. Finally, the analysis provided seven main factors in developing NBT.

Table 2. Thematic analysis of semi-structured interviews

№	Initial code	Concept	Theme
1	Changes in policies and strategies as a result of a change in management	Managerial stability	Tourism development requirements
2	Management dependency on political changes		
3	The inefficiency of the country's tourism organization	Tourism governance structure	
4	Undefined roles of each organization in tourism development		
5	Lack of regional financial capacity for tourism development	Budget allocation	
6	Insufficient programs to benefit from allocated budgets		
7	Lack of detailed guidelines for the development of NBT activities	Guidelines and instructions	
8	Not considering the region's carrying capacity requirements in tourism planning		
9	Managers' inability to evaluate natural potential	Specialized managerial skills	New managerial initiatives
10	Lack of specialized NBT management		
11	Insufficient attention to scientific studies, including systematic analyses of the tourism system and environmental baseline studies	Knowledge management	
12	Lack of information sharing between related organizations		
13	Importance of considering existing research for planning		
14	The importance of policymaking in developing NBT in the future	Forward-looking management	
15	Lack of in-depth studies for future tourism planning		
16	Need to determine the future vision for NBT		
17	Insufficient focus on tourism as a development priority	Prioritizing tourism	Political support and planning
18	Lack of government support for NBT		
19	Tourism is not seen as an option for economic development		
20	Lack of commitment to national land-use planning	Implementing plans	
21	Unimplemented Tourism Master Plan		
22	Governmental and non-governmental organizations' poor performance		
23	Need to revise provincial tourism development plans		
24	Lack of cooperation between public organizations	Integrated Management	Democratic approach
25	Lack of comprehensive, integrated, and long-term vision		
26	Lack of cooperation between neighboring provinces in developing tourism		
27	The importance of involving organizations alongside the Ministry of Cultural Heritage, Tourism, and Handicrafts		
28	Need for NGOs' involvement in planning	Local participation	
29	Lack of local's participation in tourism planning		
30	Need for local investment in NBT plans		

№	Initial code	Concept	Theme
31	Need to increase the length of stay of the tourist	Destination supply and demand management	Destination management
32	Increase in the number of domestic tourists due to rising temperatures in many other parts of Iran		
33	Strong seasonality		
34	Ignoring the importance of climate in tourism planning	Specific climatic potentials	
35	NBT potential due to suitable climate conditions		
36	Failure to identify the potential and activities of NBT	NBT resource management	
37	Availability of natural potential and attractiveness for NBT		
38	Lack of environmental policies	Sustainable approach to planning and policymaking	Sustainability
39	Improper use of natural potentials		
40	Lack of respect for rules governing the protection of natural resources		
41	Prioritizing economic interests		
42	Ignoring the human impacts on nature	Environmental impact management	
43	Degradation of the natural environment due to the increase in NBT activities		
44	Importance of climate change impacts on NBT development	Climate change impact management	
45	Importance of environmental vulnerability as a result of the effects of climate change		
46	Failure to accept natural resources as the country's national capital	Awareness raising and understanding	Awareness
47	Degradation of nature by local people		
48	Lack of education on respect for nature		
49	Need to raise awareness of the importance of environmental conservation among locals and tourists		
50	Need for local knowledge in the tourism planning process		
51	Need for awareness-raising on NBT features among managers		

Tourism development requirements

The participants addressed a few factors as prerequisites for developing NBT, allowing the authors to develop four concepts: tourism governance, managerial stability, budget allocation, and guidelines and instructions. In particular, the significance of tourism governance and its poor structure in Iran was highlighted by several interviewees. This issue is not only limited to the development of NBT. Respondents also underscored the need for managerial stability. Organizational changes due to personnel changes in an affiliated organization can obscure role clarity, resulting in conflict and increased ambiguity for the involved employees (Verlinden, Wynen, Kleizen, & Verhoest, 2022). A participant commented on the absence of tourism governance, stating,

"When the main organization is weak, the whole tourism system collapses. The roles are not fully defined for everyone" [P2].

Similarly, another participant argued the problem of managerial instability, stating,

"As people (managers) change, all policies and strategies change, which is our management system's biggest drawback. We lack long-term planning and a common goal" [P7].

Budget allocation was also mentioned as one of the strategies for facilitating NBT development. Since individual provinces cannot independently allocate the required funds, it is necessary to apportion budgets specifically for specialized tourism projects while ensuring concomitant and long-term follow-up consultations and feedback. The authors believe that confusion in the task and agenda performance leads to passivity in using allocated financial resources. One of the respondents can be directly quoted in this regard:

"In the governor's meetings, they say that the budget has been approved for the development of tourism, but they do not know how to spend it, and then they return the budget" [P13].

Most responses emphasized the importance of carefully considering the initiatives for destination management, particularly in areas where the natural resources have substantial value and where the discourse surrounding resil-

ience and the capacity to meet the host community's and tourists' needs outweighs that of other sources. In addition, several respondents noted that developing guidelines and instructions for NBT to preserve natural attractions is necessary. One respondent remarked:

"Rules for natural areas, including checking the carrying capacity of a natural area or identifying areas that are allowed for tourist entry or residence; none of which are defined" [P10].

New managerial initiatives

Due to the changing nature of tourism and the competitiveness of destinations, conventional management strategies are deemed ineffective for modern tourism development. Respondents highlighted that new management tools include specialized managerial skills, knowledge management, and forward-looking management, which are not limited to the development of NBT. However, a specialized branch of tourism necessitates distinctive management skills. One respondent stressed the need for specialization in NBT development, stating,

"In my opinion, tourism in Iran is not specialized, which means that you can easily apply for a travel agency license, and you can arrange any tour you want with that license, whether cultural, natural, religious, etc. This is a structural weakness" [P4].

In addition, a country's natural resources are recognized as valuable assets. However, it is necessary to transform them into attractions through knowledge management to create, organize, use, and share collective knowledge to gain a competitive advantage (Girard & Girard, 2015) and enhance the performance of national tourism organizations. Knowledge management represents an innovative approach to managing information and human resources that can contribute to the tourism industry's growth. However, some participants pointed out that managers tend to overlook existing knowledge. As one respondent stated:

"Studies and many projects are done in this area. Natural areas, for example, were explored to identify potentials, but these studies are not used for planning" [P15].

Effective management is formulating policies, making decisions with an eye toward the future, and considering the current situation. Consequently, forward-looking management is a key component of any country's development plan, seeking to identify gaps in previous plans and learn from them. As mentioned by a participant:

"If the management is based on the current situation, a favorable future for the future of NBT in the region cannot be imagined, but if the planning is based on new trends, Ardabil's ecotourism potential is certainly very high and can play a major role in the local economy" [P6].

This quote emphasizes the importance of implementing sustainable development practices through up-to-date plans to respond more effectively to future challenges.

Political support and planning

Planning for tourism development requires a country's political will to prioritize tourism in developing and implementing plans. Several participants mentioned that developing tourism is not among the priorities of Iranian authorities at the macro level. Prioritizing land use requires communicating pertinent discussions with political and decision-making institutions. Decision-makers have not yet shifted from nonrenewable resources and have tied their current needs to past resources; it is unrealistic to anticipate that tourism development requirements will be met without the necessary political support. Little governmental support is available for NBT development. According to one respondent:

"I see a perfect future for NBT, as long as there is a belief among the authorities that tourism can take the place of oil revenues and that planning is done for its implementation, along with receiving funding" [P7].

In addition, an important issue in NBT planning is the follow-up, continuity, and cohesive connection between written documents for long-term development. Due to the sensitivity of tourism to change, planners and implementers must regularly update their knowledge and be prepared to face new challenges. In this regard, one respondent mentioned shortcomings in the implementation of tourism plans:

"Development plans have been written but have not yet been implemented / such as a comprehensive provincial plan that has expired should be revised" [P1].

Democratic approach

An essential factor influencing the development of NBT is the democratic approach to tourism management and planning, which includes concepts of integrated management and local participation. Multiple participants mentioned a lack of cooperation and involvement among relevant organizations in developing NBT, not only in Ardabil province but also at the national level. Effective and appropriate communication between organizations is lacking. Integration and synergy in provincial programs with shared objectives are of great importance. For example, one respondent highlighted the issue of independent operations by neighboring provinces, stating:

"We have problems with neighboring provinces. If the planning is integrated, it is in the interest of all three provinces, but each province operates independently, and the tourism profit is not distributed equally" [P12].

Participation in a democratic approach to tourism requires those affected by a decision to have the right to participate actively in the decision-making. Participants believe the local community's participation is essential in achieving NBT development goals. This can be attained through good education and justifying the shared goals between the visiting and host communities. One respondent elaborated on the importance of local participation:

"We try very hard to tie the interests of the local communities in some way with the protection of nature, which means that the local community knows that the livelihood that has been created for it is due to the preservation of this nature" [P14]

Destination management

Based on findings, destination supply and demand management, specific climatic potentials, and NBT resource management are all important in nature-based destination management. Managing the destination's supply and demand lengthens tourists' stays, allowing them to maximize their vacation opportunities while contributing to the local economy. However, one of the challenges associated with managing nature destinations is the issue of seasonality. The participants highlighted monitoring climate change and forecasting appropriate vacation times as potential solutions for managing destination supply and demand. One respondent described the seasonality phenomenon in Ardabil as follows:

"Another problem is the lack of growth in NBT in the region due to its seasonal nature, and unfortunately, we are not active in autumn and winter, and visits are generally one-day" [P5].

Ardabil province has diverse climates that have yet to be leveraged as potential for NBT development. Creating specialized intra-organizational working groups dedicated to assessing and identifying specific climatic potentials of each region can improve the quality of holiday management decision-making and planning. One respondent highlighted this significance:

"Temperature differences create different climates for us. We must use these climates by designing climate atlases and planning to have tourists every 12 months of the year" [P3].

Furthermore, in managing NBT destinations, the existence of potential is a double-edged sword. As tourism natural resource management is linked to sustainability in long-term planning, the more potential and resources there are, the greater the need for attention and research. One respondent has pointed out the importance of resource management in NBT development, stating,

"One of the important factors in developing NBT is the use of resources. What more potential should we use to develop these areas better? For example, is it better to plan for NBT activities such as mountaineering, forest areas, or protected areas for development?" [P1].

Sustainability

The concept of sustainability in NBT should be considered in planning, policy formulation, and impact management of this type of tourism and climate change. The findings indicate that the depletion of natural resources in Ardabil is primarily attributed to the lack of well-defined plans and strategies. This issue arises as a result of inadequate coordination, confusion, and divergent objectives among executive entities. Meanwhile, the participants emphasized the need for a sustainable planning and policymaking approach for NBT. For example, one participant commented on the degradation of natural resources:

"... But in recent years, due to the lack of proper management of natural resources, unfortunately, our natural resources have been exposed to degradation and destruction" [P3].

Environmental impact management of NBT development is another important tool for reducing negative impacts on natural resources and improving the outdoor recreation experience. The absence of carry capacity studies in the province's macro-management for estimating the capacity of tourists in natural areas exacerbates behavioral anomalies in the destination environment. Tourists' non-pro-environmental behavior accelerates environmental degradation and eradicates the local community's indigenous culture (Tang et al., 2022). One participant brought up the destructive tourists behavior:

"Based on my experiences, I can point to the destructive effects that tourists make on nature, such as throwing garbage - disrupting the natural order of the environment - feeding animals" [P8].

Considering the importance of climate change impacts on natural areas and the dependence of nature-based activities on climatic conditions, managing the consequences of climate change is essential to developing NBT. According to participants, climate change's significant impacts on natural areas cannot be overstated, and if they are not properly managed, negative consequences could prevent NBT development. They mentioned that if climate change is managed rationally, various areas can benefit from tourism. Otherwise, these adverse effects on natural

areas may be a demotivating factor for NBT development. One participant mentioned climate change's dual role:

"The effects of climate change can be positive because it produces a new spatial flow, but in a sense, because there is not enough management, it can be a negative factor and challenge natural areas" [P6].

Awareness

According to the findings, awareness and understanding are the most critical determinants of the future development of NBT. Like the two sides of the same coin, to increase stakeholders' knowledge and understanding of the contributions of NBT development, improving the mechanisms of knowledge exchange and communication between managers and the local community is essential. According to several participants, a lack of understanding of how to approach the nation's capital from both policymakers and the local community's perspectives resulted in destruction and a lack of concern for environmental protection. In addition, there is a disagreement between the government and locals regarding natural resources as the country's assets due to the absence of protection laws. One participant said:

"We have no law to protect natural resources, and everyone allows themselves to be treated in any way because they do not consider them a national capital" [P11].

Other participants believed that the lack of reasonable communication and accurate perception between the highest and lowest levels of the executive bodies is the primary cause of the recent destruction of the natural environment. There is a lack of awareness regarding preventing environmental degradation in Ardabil. Unawareness on the part of tourists regarding their responsibility to protect the environment is another issue contributing to environmental degradation in Ardabil's natural sites. Two respondents pointed out this challenge:

"Tourists are not aware that they are responsible for protecting the environment. We can see the destruction of the environment at its highest level in the region's nature tourism sites" [P14].

and

"We should act according to the principles and rules because natural attractions are vulnerable assets. Public awareness can be effective in this regard" [P9].

Discussion

This study attempted to identify the critical factors shaping NBT's future development. Every destination's future is unknown. Thus, destination managers must make decisions in a complex and uncertain setting, considering internal and external factors (Makian & Nematpour, 2021). Based on the findings, careful consideration must be given to the following factors to ensure that nature destinations are developed sustainably through NBT: *tourism development requirements, new managerial initiatives, political support and planning, democratic approach, destination management, sustainability, and awareness*.

This study suggests that the development of NBT in less-developed nature destinations depends on several development requirements, including managerial stability of the related organizations, an effective tourism governance structure, budget allocation, guidelines, and instructions. The importance of managerial stability has been emphasized in promoting tourism development (Ozguzel, 2020), which is in an administrative system's design, operation, and direction over time, contributing positively to the overall system's performance (O'Toole, 2004). The present study highlights the need for an effective tourism governance structure that enables industry and other private and public stakeholders to coordinate, cooperate, and collaborate in effective, rational decision-making and management processes (Islam et al., 2018). Meanwhile, as supported by the findings, Petursson and Kristofersson (2021) also discussed the impact of ambiguity on actors' roles in coordinating the governance system.

Based on the findings, budget allocation and management are critical in achieving optimal NBT development. The authors believe that the tourism budget allocation issues in Iran are related to the country's central, top-down budgeting system, which requires reform following the socio-economic needs of the society (Firouzfar, 2012). When it comes to managing natural resources, it is critical to provide concise guidelines and instructions to stakeholders of NBT, including tour operators, tour guides, locals, and tourists. Since various organizations manage natural resources in Iran, they are regarded as shared resources that anyone can utilize; therefore, it is essential to create local regulations and adopt international ones. Abou and Hady (2019) believed the institutional framework could be strengthened by establishing specific guidelines and rules for providing related products and services, especially at the supply level.

Considering the shift from undifferentiated mass tourism to more custom-tailored experiences, Monaco (2018) highlighted the need for new managerial initiatives in NBT development. This requires specialized managerial skills, knowledge and forward-looking management. To plan for the future of NBT in Ardabil province, local tour-

ism stakeholders should engage in foresight- a participatory knowledge gathering process- that identifies potential trends and factors affecting the sector locally (Makian & Nematpour, 2021). This can assist stakeholders in anticipating and adapting to change. The findings also highlighted the importance of knowledge sharing in promoting solutions for environmental preservation, as it allows tourism organizations to promote best practices, facilitate knowledge creation, and improve effectiveness and efficacy (Yiu & Law, 2014), when the organizational structure is subject to governance complexity (Gajdošík & Valeri, 2022), especially in countries like Iran.

The authors believe that the managerial-political body of the Iranian government is unaware of the significance of tourism research and the knowledge-generation roles of researchers; therefore, knowledge transfer and learning in Iranian NBT-related organizations necessitate the establishment of an appropriate knowledge-sharing context, allowing for the effectiveness and efficiency of various decision-making agendas. The importance of knowledge management in achieving sustainability in tourism is also pointed out by Ruhanen (2008). Remarkably, Räikkönen et al. (2023) emphasized incorporating scientific knowledge and research into NBT activities to improve visitor experiences and promote sustainable tourism practices in more developed countries.

The findings also highlight the importance of political support. Tosun (2006) also emphasized this point, stating that many developing countries lack centric political will, necessitating the assistance and collaboration of national and international organizations to overcome this political barrier and facilitate the emergence of a participatory tourism development approach and NBT. Given political issues and the Iranian government's emphasis on economic growth over environmental protection, it may be challenging for Iran's national bodies to prioritize tourism simply in policymaking and planning. However, according to Tosun (2001), re-structuring the public administration system toward decentralization and community empowerment can strengthen the political will in developing countries for sustainable tourism development.

Importantly, the results highlight the necessity of local participation in NBT development. Meanwhile, according to Zielinski et al. (2021), local communities in developed countries are more capable of initiating or participating in tourism development due to their enhanced understanding of tourism, government policies, infrastructure, and dependence on domestic tourism. The findings also emphasize the significance of a democratic approach, as Teles da Mota and Pickering (2021) believe. This approach recognizes integrated management as an essential governance tool for the immediate needs of decision-makers for the future development of NBT, including active socio-environmental organizations and institutions. Integrated management systems effectively interact with all tourism stakeholders, developing and implementing a series of internally correlated processes that result in the more prudent use of available resources (Ionescu et al., 2018). In addition, the right policy, structured control, and synergy between various parts of the decision-making sides will be the foundation for effective communication and, ultimately, the desired feedback for Iranian tourism authorities.

Furthermore, according to the findings, natural area destination management is a multifaceted process that includes destination supply and demand management, consideration of specific climatic potentials, and NBT resource management. One aspect of destination management is balancing supply and demand, including addressing seasonality and generating interest in nature-based destinations (Pearce, 2016). Destination managers can avoid over-tourism and ecosystem degradation by managing supply and demand. However, despite the increase in demand, there is a challenge in extending the length of tourists' stays in Ardabil, which must be considered in future planning. Meanwhile, natural attractions have unique characteristics, such as climatic potential, which can be considered in planning. Tkaczynski et al. (2015) believe that engaging in nature-based activities in a climate-variable destination is a major draw for tourists, influencing demand for specific activities. This is particularly relevant in the case of Ardabil, which has a diverse climate. Tourism planners in Iran can capitalize on these opportunities by designing a holiday calendar based on each region's climate. On the other hand, NBT resource management can be viewed as balancing the conservation of natural resources and promoting tourism development through identifying and prioritizing potentials. This management approach emphasizes the significance of considering an area's environmental characteristics to assess its tourism potential and guarantee that the natural resources are utilized sustainably. In addition, this highlights the necessity of evaluating natural resources when selecting the appropriate regions for NBT development, as also suggested by Rahayuningsih et al. (2016).

The future development of NBT requires considering the sustainability paradigm in policymaking and planning and managing environmental and climate change impacts. A sustainable approach to tourism policymaking, as also highlighted by Dhami et al. (2017), aligns with NBT planning, which prioritizes preserving natural resources. However, despite implementing tourism sustainability strategies in policymaking and planning, the prioritization of economic growth over the welfare of local communities and environmental preservation has been observed (Sørensen & Grindsted, 2021). Similar challenges exist in the province of Ardabil, where the development of NBT is highly dependent on the quality of regional en-

vironmental assets. Therefore, based on findings, environmental impact management is crucial in less developed destinations. In contrast, according to Faraji Vaghaslo et al. (2023), developed countries tend to prioritize environmental indicators due to heightened concerns regarding the environmental impacts of NBT development. A regulatory framework is thus necessary to evaluate the effects of NBT activities on the environment, enabling management plans to align with long-term sustainability goals (Canteiro et al., 2018).

On the other hand, climate change is a critical aspect of sustainability, and its related issues will cause nature-based destinations to lose attractiveness (Alizadeh, Mirzaei, & Dittmann, 2021). Accordingly, potential personal risks/threats to visitors caused by climate change impacts, as noted by De Urioste-Stone et al. (2016), may play a crucial role in travel behavior, such as selecting a tourism destination. As a result, given Iran's future warmer temperatures and drier zones (Rahimi et al., 2013), the findings suggest that climate change management be incorporated into sustainable development plans to reduce the risk associated with these impacts while maintaining the attractiveness of natural destinations.

The final concept in developing NBT involves raising awareness among managers, tourists, and locals about the benefits of conserving natural assets and developing tourism. Insufficient awareness has been identified as a barrier to tourism development in Iran, including a lack of awareness among locals (Aref, 2011) and inadequate environmental awareness (Kolahi et al., 2014). As Qiu et al. (2021) stated, positive relationships between visitors and nature may enhance visitors' awareness of the interdependence of human and nature's well-being, encouraging them to protect and use natural destinations from a sustainability perspective, thus promoting harmony between humans and nature. In contrast, Li et al. (2021) argue that developed nations, having already fulfilled their basic needs, exhibit a heightened level of awareness regarding preserving their natural environments for the benefit of future generations, demonstrating a greater understanding of sustainability issues. Therefore, young Iranians must receive education about environmentally conscious behavior in schools. In the meantime, in developing countries, NGOs play a significant role in training locals and tourists on relevant topics (Kennedy & Dornan, 2009).

Conclusion

This study constitutes a specialized and contextually nuanced contribution to the large discourse on NBT development. In conclusion, it is imperative to carefully consider several factors to ensure the sustainable development of nature destinations through NBT. These factors include the requirements for tourism development, implementation of new managerial initiatives, political support and planning, adoption of a democratic approach, effective destination management, promotion of sustainability and raising awareness. Therefore, the findings may have the potential to contribute to policy formulation, inform the decision-making processes and support the development of sustainable strategies for NBT in regions like Ardabil province of Iran. As awareness and understating are important factors for NBT development, the findings of this study enable a deeper understating of NBT complexities by the relevant Iranian authorities. Furthermore, it provides policymakers and managerial stakeholders with substantial information regarding the necessary macro- and micro-level requirements crucial for the holistic development of NBT.

In a non-democratic society, such as Iran, that lacks support for developing knowledge-sharing, it may be challenging to implement the solution of determining nature's guidelines and rules. In this instance, potential solutions may include grassroots activism, lobbying of government officials, and public education about the significance of nature-based sustainable development. Bringing the sub-society closer to the active and accountable body in the relevant departments can raise awareness among the affiliated institutions and the general public. All decisions must be encompassed by "environmental democracy" (Parola, 2013), giving locals a peaceful attitude toward nature. Another approach could be to work within the existing frameworks, such as industry associations or business groups, to encourage their members to adopt sustainable practices. Building networks and partnerships can create a culture of collaboration and information sharing that can help drive sustainable development. Ultimately, the solution will depend on the context and challenges of less-developed destinations.

Practical implications

The findings of this study have various practical implications. Regarding local engagement and knowledge sharing, it is recommended to foster community participation by organizing local and regional workshops and information sharing networks. It is suggested to develop specialized training programs for managers and operational planners to enhance their understanding of executive-level realities and improve decision-making within NBT development. Considering the importance of raising public awareness about the value of nature and environmental conservation, developing and widely distributing a clear code of conduct and guidelines for visitors is suggested,

highlighting respectful and environmentally conscious behaviors while enjoying NBT activities. On the other hand, for developing climate change adaptation strategies for NBT, one suggestion could be conducting thorough vulnerability assessments of NBT sites to identify specific climate-related risks and potential impacts, such as extreme weather events or shifts in biodiversity.

Limitations and avenues for future research

This study also has limitations. Firstly, the field of NBT in Iran is relatively niche, with few specialists available for consultation. Secondly, the findings are context-specific and may be generalized to all nature-based destinations but only to those with the same characteristics as the case study. Thirdly, future studies are advised to employ alternative data collection methods as this may yield additional or supplementary results. Finally, while Iran is typically portrayed as a cultural destination, tourism authorities can use the findings of this study to diversify products and services based on the development of NBT, thereby enhancing the destination's competitive advantage. It is important to note that a greater understanding of the factors that influence the development process can aid in planning for the future.

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