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ESTADÍSTICA ESPACIAL AL SERVICIO DEL TURISMO: UNA APLICACIÓN AL CASO DE EXTREMADURA

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PROGRAMA DE DOCTORADO EN ECONOMÍA Y EMPRESA

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«Nada en la vida es para ser temido, es solo para ser comprendido. Ahora es el momento de entender más, de modo que podamos temer menos»

Marie Curie (1867 – 1934)

A mis padres

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RESUMEN

En los últimos años se observa un incremento de la importancia del espacio y de la interacción espacial entre las ciencias sociales. Pero si existe un sector económico en el que dicha corriente esté cobrando especial importancia es, sin lugar a duda, en el sector turístico. El turismo es un fenómeno geográfico y, por tanto, conocer cómo se distribuyen y relacionan sus variables en el espacio constituye una valiosa fuente de información para realizar una correcta gestión de la actividad turística. Es por ello, que el presente trabajo de investigación parte con el objetivo de indagar sobre el patrón existente en la distribución del turismo en una región de interior, el caso de Extremadura

Para ello, en primer lugar, se utilizan las medidas de asociación espacial para analizar el patrón existente entre dos de las variables más representativas de la actividad turística, el número de viajeros y el grado de ocupación.

Posteriormente, se contrasta mediante el empleo de técnicas de estadística espacial diferentes a las medidas de asociación espacial, tradicionalmente utilizadas para este fin, la existencia de una distribución no aleatoria de la actividad turística. Para ello, se estima una función de intensidad turística mediante tres métodos alternativos: función K (r) de Ripley, función de densidad de Kernel y conteo por cuadrantes.

Para finalizar, se propone un modelo que presente un buen grado de ajuste con el patrón espacial de alojamientos observado. Para este fin, la intensidad turística es modelada mediante un proceso no estacionario de Poisson, que pretende contribuir a que las estructuras identificadas puedan ser caracterizadas, mapeadas y medidas, con el fin de poder convertirse en una valiosa herramienta para la gestión público-privada de la actividad turística en la región.

Key words: Análisis Exploratorio de Datos Espaciales, Modelización Estadística, I Moran, LISA.

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ABSTRACT

In recent years there has been an increase in the importance of space and spatial interaction between the social sciences. But if there is an economic sector in which this current is gaining special importance, it is, without a doubt, in the tourism sector. Tourism is a geographical phenomenon and, therefore, knowing how its variables are distributed and related in space constitutes valuable information for the correct management of tourist activity. That is why the present research work with the objective of investigating the existing pattern in the distribution of tourism in an inland region, the case of Extremadura.

To do this, first, spatial association measures are used to analyze the existing pattern between two of the most representative variables of tourist activity, the number of travelers and the degree of occupancy.

Subsequently, the existence of a non-random distribution of tourist activity is contrasted by means of the use of spatial statistics techniques different from the spatial association measures, traditionally used for this purpose. To do this, a tourist intensity function is estimated using three alternative methods: Ripley's K (r) function, Kernel density function, and quadrant counting.

Finally, the model that presents a good degree of adjustment with the spatial pattern of accommodation is proposed. For this purpose, the tourist intensity is modeled through a non-stationary Poisson process that aims to help the identified structures to be characterized, mapped and measured, in order to become a valuable tool for the public-private management of the city. tourist activity in the region.

Key words: Exploratory spatial Data Analysis, statistical modelling, Moran I, LISA.

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Índice de contenidos

1. TESIS COMO COMPENDIO DE TRABAJOS PUBLICADOS PREVIAMENTE

TESIS COMO COMPENDIO DE TRABAJOS PUBLICADOS PREVIAMENTE

La presente tesis doctoral se presenta, autorizada por los directores de tesis y la Comisión Académica del programa de Doctorado en Economía y Empresa (R20), como un compendio de cuatro trabajos publicados previamente, cuyas referencias completas son las siguientes:

- Rodríguez-Rangel C., Sánchez-Rivero M. (2019) Analysis of the Spatial Distribution Pattern of Tourist Activity: An Application to the Volume of Travellers in Extremadura. In: Artal-Tur A., Kozak M., Kozak N. (eds) Trends in Tourist Behavior. Tourism, Hospitality & Event Management. Springer, Cham. https://doi.org/10.1007/978-3-030-11160-1_14

- Rodríguez Rangel, M.C.; Sánchez Rivero, M. (2020). Spatial Imbalance Between Tourist Supply and Demand: The Identification of Spatial Clusters in Extremadura, Spain. *Sustainability*, 12, 1651.

  Doi: https://doi.org/10.3390/su12041651

- Rodríguez Rangel, M.C.; Sánchez Rivero, M.; Ramajo Hernández, J. (2020). A Spatial Analysis of Intensity in Tourism Accommodation: An Application for Extremadura (Spain). *Economies*, 8, 28.
  Doi: https://doi.org/10.3390/economies8020028

- Rodríguez-Rangel, M.C.; Sánchez-Rivero, M.; Ramajo-Hernández, J. (2020). Spatial Intensity in Tourism Accommodation: Modelling Differences in Trends for Several Types through Poisson Models. *ISPRS Int. J. Geo-Information*, 9, 473.
  Doi: https://doi.org/10.3390/ijgi9080473

2. INTRODUCCIÓN GENERAL

INTRODUCCIÓN GENERAL

La actividad turística está siendo reconocida como un importante aliado para estimular la economía, así, se ha consolidado como el principal motor impulsor de la economía española tras la crisis financiera, ganando cada vez un mayor peso sobre el PIB y el empleo en el ámbito nacional. En el ámbito particular de las economías regionales la situación no es diferente, existe un consenso generalizado de la potencialidad de esta actividad para contribuir al desarrollo económico, reduciendo asimetrías regionales, creando empleo y generando externalidades positivas que afectan a otras actividades económicas (Soukiazis y Proença, 2008). Es por ello, que las diferentes Administraciones Públicas realizan esfuerzos constantes que permitan a los destinos posicionarse de forma exitosa en el panorama turístico. Esta realidad es especialmente palpable en aquellos casos de regiones de interior que, por estar situadas en ubicaciones aisladas, ven en el sector turístico su única oportunidad de crecimiento (Irvine & Anderson, 2003) realizando una apuesta decidida por el desarrollo de esta actividad.

La región de Extremadura se encuentra ubicada en el suroeste de la Península Ibérica, haciendo frontera con Portugal. Se trata, por tanto, de una región de interior caracterizada por contar con una amplia superficie, siendo sus dos provincias las más extensas de España, y con una población dispersa, lo que le ayuda a tener una baja densidad poblacional (26 habitantes por km^2) y un alto índice de ruralidad (algo más de la mitad de la población vive en municipios de menos de 10.000 habitantes). Atendiendo a su economía, la región se sitúa en penúltima posición nacional, solo por delante de Melilla, con respecto a su PIB per cápita en el año 2019 (Contabilidad Regional Española, INE). Esta falta de convergencia con respecto a la economía española puede ser atribuida al exceso de dependencia que la economía extremeña ha tenido tradicionalmente del sector agrícola-ganadero. Tal y como señalan Parejo y Rangel (2014), el lento crecimiento económico que ha experimentado la región se encuentra originado por las escasas posibilidades de generación de riqueza del modelo de especialización agraria en el que se ha basado la economía extremeña históricamente. En este contexto, la diversificación de la economía mediante la terciarización de la misma, apostando por sectores dinámicos como es el caso del turismo, puede presentarse como una buena opción para generar un modelo de desarrollo sostenible que permita afrontar los desafíos que presenta la economía extremeña en la actualidad.

Así, la región considera el turismo como un "sector económico estratégico al que le atribuye una gran capacidad de creación de riqueza, especialmente de crecimiento de empleo y renta, y que contribuye a potenciar la imagen de Extremadura a nivel nacional e internacional", y así lo plasma en la Ley 2/2011 de 31 de enero de Desarrollo y Modernización del Turismo en Extremadura. Esta visión de la actividad turística como sector estratégico en la región se ve, a su vez, fundamentada por una serie de cambios en la demanda turística hacia nuevas formas de turismo que posicionan a la región, gracias a su rico legado patrimonial y natural, en una buena posición para poder competir en el mercado turístico. De esta forma, se establecen como pilares básicos del turismo de Extremadura dos de los segmentos con mayor potencial de crecimiento: el turismo de naturaleza y cultural.

Todo ello ha contribuido a que la administración regional realice una apuesta decidida por el desarrollo de la actividad turística, que se ha visto materializada en una notable expansión de la oferta de alojamientos en la región basada en políticas de ayudas y subvenciones para la mejora de la infraestructuras hoteleras y extrahoteleras, mediante la mejora o rehabilitación de alojamientos en Extremadura (Sánchez-Rivero, 2014), que a su vez se ha visto acompañado por la apuesta decidida por el desarrollo rural realizado por la Unión Europea.

Pero para que este sector pueda cumplir con los propósitos que justifican su fomento por parte de la administración regional resulta imprescindible una adecuada gestión y planificación de los recursos existentes. Esta planificación, por su parte, requiere de información exhaustiva sobre la situación actual del sector para poder lograr los objetivos que se persiguen y, por este motivo, existe un interés creciente de información sobre la actividad turística. En efecto, la industria turística ha estado tradicionalmente caracterizada por su enorme dependencia de un sistema de inteligencia que le permita contar con datos exhaustivos sobre diversos aspectos de la actividad turística para, de esta forma, realizar una planificación adecuada de los destinos. Esta necesidad de información, propia de la gestión de cualquier destino turístico, se ve acentuada cuando se trata de destinos en fase de crecimiento que, a su vez, requieren de información precisa y detallada que les permita realizar una planificación adecuada de la dotación de infraestructuras necesarias para lograr un desarrollo adecuado del sector, como es el caso de la región de Extremadura. Es por ello, que el presente trabajo de investigación parte con el principal objetivo de indagar sobre cuál es la realidad del sector turístico en esta región, utilizando para ello las técnicas que se consideran más apropiadas atendiendo a las características de la actividad a analizar.

Entender la realidad de una actividad económica requiere conocer su historia y evolución. En el caso particular que ocupa esta investigación, la evolución de los establecimientos turísticos de Extremadura no puede ser entendida sin analizar el impacto que sobre los mismos ha producido las ayudas provenientes de la Unión Europa, que persiguen la creación de un modelo de desarrollo rural común europeo. Un buen ejemplo de ello lo constituye la iniciativa LEADER (Liaison Entre Actions de Dévelopment de L´Economie Rurale). Este programa fue inicialmente puesto en marcha en la región en el año 1991 y, desde entonces, ha supuesto una serie de inversiones que, si bien en su finalidad más amplia se encuentran orientadas a incentivar el desarrollo rural, mediante la mejora del desarrollo económico, frenando los procesos migratorios y diversificando las actividades económicas, han tenido un impacto significativo en la evolución del sector turístico en particular, teniendo especial incidencia en el aumento de la planta alojativa de Extremadura.

Para comprender el calado de estas ayudas sobre el territorio de la región basta con observar la extensión total que ha quedado bajo la influencia de una de las herramientas utilizadas para la gestión de estos fondos, los denominados Grupos de Acción Local (GAL). Estos grupos se constituyen a nivel microterritorio, utilizando como referencia las comarcas turísticas, y tienen como función implementar y gestionar los diferentes planes de acción debidamente adaptados a los recursos de cada tipo de territorio en los que queda divida la región mediante los mismos. Pues bien, para el caso concreto de la región objeto de estudio de la presente tesis doctoral se crean un total de 24 GAL que engloban un total de 384 municipios (99% del total regional) y representan el 69% de la población extremeña total (Red Extremeña de Desarrollo Rural). De estos datos se deriva que la repercusión que dichas políticas han tenido sobre los territorios beneficiados tenga una influencia palpable y que deban ser tenidos en cuenta para contar con un conocimiento exhaustivo de la evolución del turismo en Extremadura.

En efecto, el desarrollo del turismo rural en Extremadura no puede ser entendido sin considerar la influencia que las inversiones realizadas por estos programas han supuesto para el sector. Así, como se ha indicado, si bien la finalidad que perseguían estos programas estaba más centrada en potenciar las posibilidades de desarrollo de cada territorio, buena parte de su atención se ha centrado en el desarrollo del sector turístico, teniendo especial incidencia sobre: la creación de una oferta turística para cada territorio, en la conservación y rehabilitación del patrimonio histórico y artístico y en la revitalización de la vida social (Pitarch & Arnandis, 2014). Llegando, especialmente en los programas pioneros, a representar las ayudas destinadas al fortalecimiento de la planta alojativa rural el 40% de los fondos totales del programa, bien mediante la creación o la rehabilitación de nuevos alojamientos (MAPA, 2004).

Estas políticas desarrolladas desde la década de los 90 por las diferentes Administraciones Públicas han tenido un enorme calado en la configuración actual del sector turístico marcando algunas de sus características distintivas. De una parte, la creación de alojamientos se constituía en ocasiones en territorios que necesitaban la diversificación de sus actividades económicas, y no necesariamente se correspondía con aquellas ubicaciones que contaban con un mayor atractivo turístico. Por otra parte, las inversiones recibidas crearon un rápido crecimiento de la oferta, pasando de contar con una única casa rural al comienzo de estas ayudas hasta alcanzar los 797 alojamientos de esta tipología en la actualidad, que a su vez no se ha visto acompañado por un crecimiento igual de la demanda. Por tanto, nos encontramos frente a un sector con fuertes desequilibrios entre oferta y demanda que deben ser analizados y corregidos para que la actividad turística logre alcanzar aquellos fines que se persiguen con la incentivación de la misma

Una vez contextualizado el impacto que estas ayudas han supuesto en la configuración de la actual oferta de alojamientos turísticos en la región, en la Tabla 1 se puede ver cómo ha evolucionado esta magnitud en el periodo comprendido por los últimos siete años, una vez se han difuminado los efectos que la crisis económica y financiera de 2008 tuvo sobre esta actividad. Como se puede ver esta tabla presenta el número de alojamientos total y su división por las tres principales tipologías atendiendo a la clasificación realizada en la Ley 2/2011 de 31 de enero de Desarrollo y Modernización del Turismo en Extremadura. Según esta ley los diferentes establecimientos turísticos existentes en la región pueden ser recogido en tres grandes tipologías. En primer lugar, se encuentran los alojamientos turísticos hoteleros, que a su vez se dividen en: hoteles, hoteles-apartamentos, hostales y pensiones. En segundo lugar, está constituido por los denominados alojamientos turísticos extrahoteleros entre los que se distinguen: apartamentos turísticos, albergues turísticos, campamentos de turismo y zona de acampada. Por último, los alojamientos de turismo rural dentro de los que se diferencia entre: hoteles rurales, apartamentos rurales, casas rurales y chozos turísticos.

La principal diferencia que, atendiendo a la legislación vigente, sirve para caracterizar a los alojamientos rurales es, por un lado, su singularidad, pues se trata de establecimientos que presentan especiales características de construcción, emplazamiento y/o tipicidad y, por otro lado, su ubicación, ya que se encuentran ubicados en núcleos urbanos (entendiendo por tal los municipios de menos de 10.000 habitantes) o en el campo.

Como se puede ver en la Tabla 1 los alojamientos rurales constituyen más de la mitad de los alojamientos existentes en la actualidad en Extremadura, lo que atendiendo a la

descripción de la tipología y las características de la región no resulta de extrañar. Si se analiza su evolución se observa que actualmente, si bien se ha ralentizado su ritmo de crecimiento, sigue aumentando el número de alojamientos existentes de esta tipología en Extremadura. En contraste a esta tendencia se observa que la presencia de alojamientos hoteleros en la región muestra una evolución contraria, habiendo reducido su peso relativo sobre la planta alojativa de la región en el periodo analizado. Por su parte, los alojamientos extrahoteleros comienzan a cobrar fuerza y, aunque su contribución relativa a la capacidad alojativa de la región sigue siendo moderada, se consolida como la tipología que muestra mayores tasas de crecimiento en el periodo analizado.

En conclusión, del análisis de la evolución de alojamientos en Extremadura se puede destacar: por un lado, los alojamientos rurales conforman una proporción importante de la oferta alojativa en Extremadura lo que le otorga una buena oportunidad de poseer una oferta ampliamente distribuida por el territorio, por otro lado, analizando la tendencia de la oferta se observa que sigue creciendo el número de alojamientos totales existentes en la región, por lo que se puede considerar que el sector turístico en la región se encuentra en fase de crecimiento o expansión aún. Esta información debe, necesariamente ser tenida en cuenta para una correcta gestión y planificación de la actividad turística en Extremadura.

Tabla 1: Evolución de alojamientos turísticos en Extremadura por tipologías (período 2012-2019).

Tipo de Establecimiento	2012	2013	2014	2015	2016	2017	2018	2019
Hoteleros	483	475	469	458	455	453	453	451
Extrahoteleros	162	172	184	189	191	200	347	343
Rurales	705	705	730	768	743	745	770	797
Totales	**1.350**	**1.352**	**1.383**	**1.415**	**1.389**	**1.398**	**1.570**	**1.591**

Fuente: Registro de Empresas y Actividades Turísticas de Extremadura.

Si nos centramos en el análisis de la distribución territorial se ha de destacar que el aumento de la capacidad alojativa que se ha producido en la región tampoco ha sido distribuido equilibradamente por el territorio. Esto produce que, previo a una correcta gestión del destino, se haga necesario indagar sobre cuál es el patrón turístico existente, con la finalidad de poder

realizar una planificación conjunta del territorio que permita monitorizar y planificar este sector para conseguir un desarrollo óptimo del mismo. Es por ello, que la presente tesis doctoral persigue como finalidad generar conocimiento de la distribución espacial de la actividad turística mediante la aplicación de diferentes técnicas de estadística espacial.

La estadística espacial surge como aquella rama de la estadística encargada de analizar datos georreferenciados, esto es, datos que son identificados mediante sus coordenadas X e Y sobre un sistema cartográfico. La evolución de esta rama de la estadística se encuentra estrechamente ligada a su aplicación a diferentes campos de conocimiento tales como la ingeniería, la agricultura o las ciencias forestales, tal y como apuntan Gelfand, et. al., (2010).

A finales del s. XX se empieza a prestar una mayor atención a esta rama estadística incluyendo cada vez más en los análisis estadísticos los problemas espaciales y espacio-temporales, favorecido, entre otros aspectos, por tres grandes razones: un mayor peso de la variable espacio dentro de las teorías de las ciencias sociales, una mayor disposición de bases de datos georreferenciadas (facilitadas por las posibilidades ofrecidas por las nuevas tecnologías) y la difusión a bajo coste de software eficiente que permite el análisis de variables georreferenciadas, los Sistemas de Información Geográfica (SIG) (Anselin & Florax, 1995).

El uso de las técnicas propias de la estadística espacial para realizar un correcto análisis de determinadas actividades económicas viene fundamentado por dos razones, principalmente. Por un lado, asociar cada observación con sus coordenadas permite obtener información adicional para conseguir resultados estadísticos de diversa índole. O lo que es lo mismo, la geocodificación de variables permite considerar la posición relativa o absoluta en el espacio de una observación, siendo de gran ayuda esta información para interpretar importantes relaciones en, y con, el espacio. Por otro lado, en determinadas ocasiones resulta necesario considerar en el análisis el componente espacial, ya que de no hacerse así se estaría incumpliendo los supuestos básicos de la estadística clásica. En concreto, la estadística espacial surge por la necesidad de corregir aquellas situaciones en las que no se cumple uno de los supuestos básicos de la estadística clásica, la no independencia de las observaciones. A esta falta de independencia de las observaciones se le denomina autocorrelación o dependencia espacial (Cliff y Ord, 1973,1981) y está directamente relacionado con la conocida como Ley de Tobler (1979) que indica que “todo está relacionado con todo, pero las cosas cercanas están más relacionadas entre sí que las cosas lejanas”.

Ante este nuevo escenario surge un nuevo conjunto de técnicas adecuadas para tratar los denominados efectos espaciales, autocorrelación y heterocedasticidad espacial, que serán

requeridas para el tratamiento de variables geográficamente distribuidas cuando se tengan indicios de que el fenómeno objeto de estudio pudiera estar afectado por los mismos. Así, el empleo de estas técnicas se ha extendido por diferentes áreas de conocimiento, realizando lo que se conoce como minería de datos espaciales que consiste en el empleo de técnicas exploratorias con el fin de detectar estructuras, agrupaciones, asociaciones o cualquier otra forma de dependencia espacial que descarte la distribución de la variable en el espacio siguiendo un patrón aleatorio.

Así, gracias a la extensión de estas técnicas la detección del efecto de autocorrelación espacial ha sido confirmado en fenómenos de naturaleza tan diversa como en el estudio de la intención de voto en los estados norteamericanos (Cox, 1969), la propagación de epidemias (Cliff y Ord, 1981) o actividades de I+D (Anselin, et. al., 2000).

Atendiendo al ámbito de las ciencias sociales, y más concretamente del desarrollo de actividades económicas, han sido numerosos los trabajos que han podido confirmar la presencia de este efecto en cuestiones tales como la producción, el paro, la renta disponible o en procesos de convergencia regional, entre otros. Este estudio ha dado lugar, incluso, a la formación de teorías que explican cómo la ubicación de las empresas en zonas en las que existe una fuerte concentración produce beneficios, tanto para empresas y sectores concretos, como para el conjunto de la economía en general, es lo que se conoce como economías de aglomeración (Marshall, 1920; Hoover, 1936; Jacobs, 1969).

Por economías de aglomeración puede entenderse el conjunto de beneficios que obtienen las empresas como consecuencia de su ubicación en cercanía a otras, pudiendo existir dos tipos; economías de localización o de urbanización, en función de si las empresas agrupadas pertenecen a la misma industria, o no (Beaudry & Schiffaverove, 2009; Hoover, 1936).Los beneficios que se obtienen de dicha concentración son los denominados “geographic spillover effect” y están basados en las economías de escala y efectos de red, pudiéndose sintetizar en: beneficios de las economías de escala mediante la intensificación de la demanda, reducción de coste de transporte y de flujos de información y una mayor accesibilidad a recursos (tanto tangibles como intangibles) e infraestructuras. Pero también hay que tener en cuenta que una elevada concentración podría no producir los mismos beneficios para todas las empresas agrupadas, produciendo desventajas como podría ser el elevado nivel de competencia. En cualquier caso, resulta evidente que tanto la interacción espacial como el posicionamiento en el espacio producen una serie de efectos sobre el funcionamiento de determinadas actividades económicas que requiere ser estudiado y analizado para una correcta gestión de estas.

Pero si existe una actividad económica que guarde una estrecha vinculación con su realización en un determinado territorio es, sin lugar a duda, la actividad turística. El turismo es un fenómeno geográfico y, por ello, un correcto análisis de la actividad turística pasa por incluir la variable espacio y la interacción espacial mediante el empleo de técnicas adecuadas para este fin. Analizar la dimensión geográfica del turismo resulta una ayuda fundamental para comprender cómo funciona esta actividad, al tiempo que permite derivar información para una adecuada tarea de gestión y planificación de un destino.

Como señala Carreras (1995) la actividad turística presenta una fuerte dependencia de los activos y atractivos turísticos y de ahí se deriva su marcada tendencia a la concentración espacial. Resulta evidente que la decisión de localización de una empresa turística va a determinar aspectos tan esenciales como la cantidad de recursos disponibles, el grado de ocupación o de estacionalidad o la intensidad competitiva (Cawley, et al., 2008; Hall, 2011; Lado, et al., 2014). Es por ello por lo que tradicionalmente se asocia a las variables turísticas una dimensión territorial caracterizada, a su vez, por una desigual distribución dentro y entre los destinos turísticos (Batista, et al., 2018).

Esta fuerte asociación territorial de las variables turísticas unida a las necesidades de información que tradicionalmente ha caracterizado a este sector ha dado como resultado una tendencia creciente en la literatura actual, con la proliferación de trabajos dentro del ámbito turístico que recurren a las técnicas aportadas por la estadística espacial para explicar y entender el funcionamiento de este sector.

Así, desde los trabajos pioneros desarrollados por Wall, et al.(1985) orientados a analizar la distribución de los hoteles en Toronto entre los años 1950-1979 con el objetivo de evaluar la tendencia temporal del patrón identificado, han sido varios los trabajos que persiguen analizar la distribución de las variables turísticas en el espacio en diferentes destinos (Majewska, 2015; Yang, et. al., 2013; Li, et. al., 2015; Xing-Zhu & Qun, 2014; Yang, et. al., 2012; Chua, et. al., 2016; Polo, et. al., 2015; Balaguer & Pernías, 2013; Sánchez, et. al, 2018).

Como conclusión general de todos ellos se obtiene que el patrón espacial de la actividad turística no obedece a una distribución aleatoria, sino que se constata la existencia de determinados regímenes de asociación espacial que merecen ser tenidos en cuenta de cara a poder generar un conocimiento exhaustivo de esa actividad en el marco territorial objeto de interés en cada caso.

La necesidad de utilizar técnicas de estadística espacial queda, por tanto, justificada por todo lo expuesto en la presente introducción, considerando que el empleo de las mismas produce una serie de beneficios que deben ser tenidos en cuenta atendiendo a las peculiares características del espacio que se pretende analizar, la región de Extremadura.

Es por ello que la presente tesis doctoral parte con el objetivo de modelizar la tendencia espacial identificada tras el análisis exploratorio del patrón de puntos de alojamientos turísticos existentes en la región de Extremadura. Se trata, por tanto, de evaluar empíricamente la tendencia espacial identificada para proponer el modelo que mejor se ajuste a ésta y que permita caracterizar, mapear y medir de forma operativa, las diferentes estructuras espaciales y la organización de la actividad en el espacio, con el fin de poder convertirse en una valiosa herramienta práctica para la gestión tanto pública como privada de la actividad turística en la región.

En primer lugar, se establece como objetivo de partida analizar si el empleo de las técnicas de estadística espacial estaría justificado para el caso particular de la región objeto de estudio, es decir, se busca contrastar si el patrón de distribución de la actividad turística en la región obedece al esperado bajo una hipótesis de distribución aleatoria o si, por el contrario, éste queda definido por alguna tendencia espacial que merezca ser estudiada y analizada. Se trata, en definitiva, de realizar lo que se conoce con el nombre de AEDE (Análisis Exploratorio de Datos Espaciales), se define de esta forma al conjunto de técnicas que permite describir distribuciones espaciales, identificando localizaciones atípicas (spatial outliers), descubriendo esquemas de asociación espacial (spatial clusters) y sugiriendo estructuras espaciales, así como otras formas de heterogeneidad espacial (Anselin, 1999). Para este fin, en primer lugar, se emplean las medidas de asociación espacial más comúnmente utilizadas en la literatura existente, realizando dicho análisis desde una doble perspectiva. Por un lado, a nivel global, considerando el espacio de la región en su totalidad e incluyendo todas las observaciones de forma conjunta. Por otro lado, a nivel local, donde se analiza cada observación de forma independiente asignando un indicador a cada una de ellas y detectando aquellos casos que concentren valores más altos (o bajos) de los esperado bajo un supuesto de distribución aleatoria.

Para el análisis de la asociación espacial a nivel global se emplean el índice I global de Moran (1948) y G(d) de Getis y Ord (1992). La ventaja de este tipo de indicadores es que permite sintetizar en un único valor la tendencia, o esquema, general espacial observada. Por su parte, a nivel local la dependencia es analizada mediante los mapas LISA (Local Indicators of Spatial

Association) propuestos por Anselin (1995) y la familia de indicadores G_i (d) de Getis y Ord (1992) y Ord y Getis (1995).

Todos estos análisis son efectuados asistidos por la ayuda del software ArcGIS que incluye un módulo de análisis y mapeo espacial que permite, bajo una perspectiva geoestadística, analizar la relación de dependencia o autocorrelación espacial mediante los índices más comúnmente utilizados. La importancia de los GIS (Geograhic Information System) en este proceso es que ofrecen aunar en un único proceso análisis estadístico y gráfico, dando lugar a lo que algunos autores denominan "visualización científica" (Haining, et al., 2000). Por otra parte, el enfoque utilizado por el software seleccionado requiere la utilización de datos espaciales de tipo punto, es decir, trabajar con observaciones determinadas por sus coordenadas terrestres de latitud y longitud. Por lo tanto, como requisito previo a la realización de los análisis desarrollados en la presente tesis doctoral fue creado el patrón de puntos espaciales (SPP por sus siglas en inglés, Spatial Point Patterns) de los recursos y variables turísticas utilizadas para la realización de los diferentes trabajos que integran la presente investigación.

Analizar el comportamiento de la actividad turística requiere conocer qué sucede con las principales magnitudes por las que dicha actividad queda representada, por esta razón, las principales variables que caracterizan la oferta y demanda del sector turístico en Extremadura fueron consideradas para este trabajo de investigación. Así, en el primer capítulo, correspondiente al capítulo del libro titulado "*Analysis of the Spatial Distribution Pattern of Tourist Activity: An Application to the Volume of Travellers in Extremadura*", se analiza de forma exhaustiva el comportamiento espacial de una variable habitualmente utilizada para medir la demanda turística, el número de viajeros llegados a la región objeto de estudio.

Para poder completar este primer análisis de la actividad turística en el capítulo dos, correspondiente al artículo titulado "*Spatial Imbalance Between Tourist Supply and Demand: The Identification of Spatial Clusters in Extremadura, Spain*", se realiza un análisis exploratorio del comportamiento de la variable *grado de ocupación*, que es utilizado como un indicador proxy del buen grado de ajuste entre oferta y demanda.

Las medidas de asociación espacial utilizadas hasta este momento han demostrado su validez para el análisis de los patrones de distribución espacial, sin embargo, las mismas presentan una serie de debilidades que deben ser tenidas en cuenta. Por una parte, los indicadores utilizados presentan una gran sensibilidad al criterio de vecindad utilizado para definir la asociación espacial (contigüidad, distancia euclídea, matriz de pesos espaciales, etc).

Por otra parte, la demarcación territorial de las unidades administrativas podría también influir en los resultados obtenidos (tamaño, forma, posición en la división territorial de la región, etc). Ésta última no representa una dificultad en la investigación desarrollada debido al enfoque seleccionado, perspectiva geoestadística. Sin embargo, y a pesar de que se han realizado diferentes pruebas para seleccionar cuál es el criterio de vecindad más adecuado, atendiendo a las características del espacio a analizar, los resultados obtenidos podrían estar influidos por la selección del criterio finalmente utilizado, pudiendo ocurrir que al cambiar éste también lo hicieran algunos de los hallazgos alcanzados.

Por ello, para dar una mayor fiabilidad y validez autores como Wall, et al, (1985) sugieren la utilización conjunta de diferentes técnicas de estadística espacial. Así, en el capítulo tres, titulado "*A Spatial Analysis of Intensity in Tourism Accommodation: An Application for Extremadura (Spain)*", se estudia la distribución de los alojamientos turísticos en Extremadura mediante técnicas estadísticas alternativas a las medidas de asociación espacial anteriormente descritas. En concreto, se contrasta la homogeneidad espacial de los alojamientos de la región mediante una función de intensidad que es estimada mediante técnicas no paramétricas: conteo por cuadrantes, función K de Ripley (1977, 1988) y suavizado de la función de densidad de Kernel (Diggle, 1985), todo ello asistido por el paquete S*patstat* de R (Baddeley & Turner, 2005).

Finalmente, una vez se da por concluido el análisis exploratorio de datos espaciales y, considerando el conocimiento alcanzado a través del mismo, se procede a estimar el modelo que se mejor se ajuste al patrón de distribución espacial observado. De esta forma, en el capítulo cuatro, constituido por el artículo titulado "Spatial Intensity in Tourism Accommodation: Modelling Differences in Trends for Several Types Through Poisson Models", se modela la intensidad turística mediante un proceso Poisson no estacionario en el que la intensidad condicionada dependerá de la localización (coordenada XY) del patrón de puntos existente. En aquellos casos en los que la intensidad dependa de la localización es posible hablar de la existencia de una tendencia espacial. La estimación de la tendencia mejor ajustada al patrón espacial observado será, por ende, el objetivo de este trabajo de investigación.

Para estimar los diferentes modelos propuestos se utiliza el método de máxima verosimilitud para modelos Poisson (Berman & Turner, 1992) con la mejora de Huang-Ogata (1999). La bondad de ajuste de los modelos es validada por el análisis de residuos representados mediante el diagrama de bondad del ajuste (Baddeley, et al., 2005; Lawson, 1993; Stoyan & Grabarnik, 1991). Por último, para identificar cuál de los modelos es el que presenta un mejor grado de ajuste respecto al patrón espacial observado, éstos son comparados mediante la

prueba de razón de verosimilitud compuesta (Baddeley, et al, 2016), seleccionando el modelo que con un número menor de parámetros se ajuste mejor al patrón observado de una cada una de las tipologías de alojamiento consideradas.

3. COPIA DE LOS TRABAJOS PUBLICADOS

CAPÍTULO 1

ANALYSIS OF THE SPATIAL DISTRIBUTION PATTERN OF TOURIST ACTIVITY: AN APPLICATION TO THE VOLUME OF TRAVELLERS IN EXTREMADURA

Chapter 14
Analysis of the Spatial Distribution Pattern Tourist Activity: An Application to the Volume of Travellers in Extremadura

Cristina Rodríguez-Rangel and Marcelino Sánchez-Rivero

14.1 Introduction

Spatial econometrics emerged as a branch of general econometrics due to the need for developing a set of techniques that would allow the adequate treatment of data affected by the so-called spatial effects: spatial autocorrelation or dependence and spatial heterogeneity. The proliferation of georeferenced databases motivates a greater need for knowing what is happening with those data in their spatial distribu- tion, and especially whether this distribution involves any structure that should be known in order to better understand the relationships that occur between the vari- ables in space. Anselin (2001) defines itas "a section of econometrics dedicated to the treatment of spatial interaction (spatial dependence) and spatial structure (spatial heterogeneity) in cross-section and panel data regression models". As can be deduced from Anselin's definition, there are two main effects that motivate the appearance of a subfield within traditional econometrics: spatial heterogeneity and spatial depen- dence or autocorrelation.

Spatial heterogeneity or lack of structural stability arose as a consequence of using different spatial units to explain a single phenomenon, and it can be solved with today's techniques for the treatment of time series (Moreno & Vayá, 2004). lndeed, as the authors indicate, the effect of heterogeneity, although it is related to the unequal distribution of a variable in space, <loes not require the development of new techniques to be treated, since this can be achieved with techniques that have already been proposed by traditional econometrics.

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CAPÍTULO 2

SPATIAL IMBALANCE BETWEEN TOURIST SUPPLY AND DEMAND: THE IDENTIFICATION OF SPATIAL CLUSTERS IN EXTREMADURA, SPAIN

sustainability

MDPI

Article

Spatial Imbalance Between Tourist Supply and Demand: The Identification of Spatial Clusters in Extremadura, Spain

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Abstract: The techniques provided by spatial analysis have become a great ally of tourist planning as they allow the carrying out of exhaustive territorial analyses. The greater availability of georeferenced databases together with the more and more extensive use of GIS (Geographic Information Systems) is materialising in the proliferation of studies analysing the distribution patterns of tourist territories. The present study uses these techniques to study the degree of equilibrium in the distribution of places and its level of occupation in a region where the use of expansionary policies of growth of the tourism sector has been able to cause a strong imbalance in said activity, i.e., the case of the region of Extremadura. To verify this, both global contrasts, global Moran's I and G (d) of Getis and Ord, are used, as well as local contrasts, to map LISA (Local Indicators of Spatial Association). The results obtained confirm the existence of strong imbalances in the e*ff*ectiveness of the places created while allowing the identification of di*ff*erent clusters of high and low values. These findings represent an important output for the strategic planning of the territory in order to develop a strategy that allows the sustainable tourism development of the territory.

Keywords: spatial statistics; spatial clusters; Moran's I; Getis–Ord G (d); LISA; Extremadura

1. Introduction

The inclusion of the space variable in economic analyses is becoming an increasing habitual practice, especially in the case of activities, which, owing to their very nature, have a close relationship with their development in a given territory, as with tourism. As pointed out by Sánchez [1], a tourist destination cannot be analysed in isolation without taking into account the influence on it of proximal destinations and vice versa. The presence of a tourist business in a certain location will determine aspects as essential as the resources available; these are understood to be the presence of attractions and their exploitation [2,3], as at the same time this a*ff*ects the occupation level, that of seasonality, and that of competitive intensity, among others [4]. Moreover, the satisfactory progress of tourist activities will also be influenced by factors such as accessibility or the supply of accommodation or complementary services [5].

The ways in which the location of an establishment in a given geographical area may influence the satisfactory progress of the activity are therefore diverse. For this reason it is not surprising that the conceptualisation of distance must be included in the statistical analyses to be performed in order to obtain an exhaustive vision of the tourist situation, and this is possible thanks to the application of the techniques of spatial statistics. This statistical tool is characterised by going further than conventional statistical analyses, including the space variable and spatial relations gathered by means of the design of a matrix of spatial weights as another parameter to be taken into account in the analysis to be performed; its use in social science is becoming more and more frequent.

This growth in the use of techniques of spatial statistics has not occurred in isolation but has been encouraged by the greater dissemination of geographic information systems (GIS) in the field of economic analysis in general and in particular, in the case of tourism. As pointed out by Anselin [6], the application of techniques of spatial statistics together with GIS extends the limits of the types of analysis that may be carried out in a realistic environment, such as those orientated towards supporting the analysis of policies or the making of decisions. It is therefore possible to synthesise the factors which have had an influence on the fact that the space variable is becoming more important in social science in the following ways: the greater importance of spatial interaction in social science, the greater availability of georeferenced databases, and the development of GIS software including specific modules allowing the statistical analysis of spatial data [7].

For all these reasons, GIS are beginning to be recognised as valuable tools for arranging, analysing, and expounding large volumes of data for any local and regional planning activities; their use is becoming imperative in tourist planning and management [8]. The main advantage of the application of GIS technology in tourist analysis is that it allows the acquiring of greater knowledge of the structure and the operation of the tourist system in a given area, either for the purpose of planning or with the objective of monitoring the development of the existing activity [9].

The analysis of the distribution patterns of the variables related to tourism, identifying whether the variables tend to be concentrated or dispersed in the space, the finding of groups with characteristics similar to those of proximal locations, or on the contrary, the finding of observations of behaviour clearly di*ff*erentiated from that of their neighbours, are some of the possibilities of spatial analysis. In other words, by means of spatial statistical analyses, two important spatial e*ff*ects can be observed: dependence or autocorrelation and spatial heterogeneity, which will have important implications for tourist management.

The main implications of the finding of interdependence relationships in space lie in the geographic spillovers associated with them. This interdependence between regions has been analysed under the agglomeration economies approach [10–12], which is based on the premise that the concentration or spatial proximity of economic activities can be beneficial due to externalities of the agglomeration for the whole economy as well as for the sectors and companies grouped in a particular location, highlighting the improvement of productivity, investments, labor market, knowledge transfer, among other aspects [13]. In this line, the works carried out by Majewska [14,15] and Majewska & Trusklolaski [16], which, based on this premise, analyse the geograhics spillovers of tourism activity in Poland and countries of central Europe, identifying the existence of di*ff*erent hot spots that represent essential knowledge for proper planning of these destinations.

In the same way, the works carried out by Yang and Wong [17] that, with the object of study being China, identified the presence of di*ff*erent hot spots in coastal areas, mountainous regions, gateway cities or higher-hierarchy cities within the country that extend its e*ff*ects beyond natural borders, as well as the existence of certain areas that constitute cold spots with a low level of tourism development. Alongside these, other works carried out for the same purpose stand out: the identification and description of the spatial pattern of tourism activity in particular territories [1,5,8–32].

As a general conclusion of all these works, it can be confirmed that the distribution of tourist activities in a region is not homogeneous [5,9,20,25,27,29,33,34]. On the contrary, this spatial distribution is characterised by a series of patterns which must be identified and taken into account for the correct management and planning of a destination.

In general terms, in analysing the distribution of the demand from travellers in the territory, it can be expected that there will be a certain preference for those locations which have the most tourist attractions. In accordance with this premise, it can be anticipated that tourist lodgings have a greater supply of beds in those locations which are more attractive to the demand, or what amounts to the same, that the beds are concentrated in the locations of greater preference of the demand. This has been the approach used by a large proportion of the studies carried out to date to analyse the distribution of tourist activity in space, i.e., assimilating that supply and demand have the same distribution

pattern. Therefore, the lack of specific details allowing the analysis of the behaviour of travellers may be compensated for by a detailed study of the behaviour of the supply [1,5,9,25].

It must, however, be taken into account that the creation of beds for tourists is not always a response to the prior existence of interest from the demand. This could be the case of the creation of beds in locations which lack a strong tourist tradition but which see in the development of this activity a good opportunity to generate wealth and employment.

This paper aims to investigate the degree of adjustment between supply and demand in a territory where, due to the particularities of the growth model implemented based on expansive policies, it has given rise to a strong imbalance between supply and demand, the region of Extremadura [1,5,25,28,32] that needs to be studied and analyzed in order to implement the appropriate strategies to achieve growth sustainable tourism in the region.

The principles on which sustainable tourism development rests based on various institutional declarations of the World Tourism Organization (UNWTO) according to Cánoves, et. al [35] can be synthesized as follows: giving optimum use to environmental resources, maintaining and helping to conserve natural resources and biological diversity, respect the cultural authenticity of host communities, conserve their cultural and architectural assets and their traditional values, and ensure long-term viable economic activities that benefit all agents and report socio-economic benefits. Therefore, the mere creation and provision of housing capacity is not enough, but for a truly sustainable economic system to be constituted, it is necessary that the distribution of these be adjusted correctly to the preferences of the demand, or what is the same, that these places obtain a su*ffi*cient occupancy rate to generate an economic benefit that allows the continuity of the business without exceeding maximum saturation levels that hinder the correct conservation of the main tourist attractions.

In this sense, the analysis of the occupation level seems to be a good option to generate knowledge from which to design development strategies that allow fulfilling the necessary objectives so that the sustainable tourism development of the area under study is possible.

Moreover, as some of the previous studies underline, one of the main weaknesses of the technique used is that the use of administrative boundary a*ff*ects the results obtained [14,15], so some of the geographic spillovers could be covered up; in order to avoid this problem, it has been decided to use a global positioning system (GPS) coordinate reference unit for each of the observation units, that is, this analysis is performed from a territorial perspective disaggregated at the highest possible level, the very location of each establishment. This study uses in total as a sample, a set consisting of 270 accommodation establishments for which data are available on their beds and occupation levels for July 2015; all these establishments are located in the region of Extremadura. The use of the establishment itself as a unit of analysis will allow the identification of a set of lodgings with similar behaviour (spatial clusters), which in view of the management of the territory, allows the definition of joint planning strategies.

The novelty of the approach used in this article must be sought in the combination of the methodology and destination used. Most of the work done to date to analyse the distribution pattern is carried out at an intra-urban scale [36,37], also selecting destinations that are in the maturity phase. The peculiarity of the analysed destination lies in the fact that it is an emerging interior destination that, due to the characteristics of tourism products with development potential in these destination, requires sustainable tourism management. Therefore, using an analysis focused on the e*ffi*ciency of the territory measured through the occupation level as a proxy indicator of tourism pressure is an important temporary spatial tool to locate possible locations that could present problems of excess load capacity. In the same way, it is essential to establish the appropriate development policies for the identification of possible locations that in the space and time analysed make less e*ffi*cient use of their available resources. Therefore, it is considered that the analysis performed is a valuable tool for public and private managers in order to manage the destination that allows its sustainable development.

In order to achieve its objective, this study is structured as follows: after this introduction, the next section details what is meant by exploratory spatial data analysis (ESDA) and what has been its

application in the field of tourism. The third section serves as a guide to the reader in the enumeration of some characteristics of the geographical scope of this study, the region of Extremadura. Subsequently, we describe in detail the methodology used in this research. Section five describes the results obtained, and finally this research is completed with a synthesis of the main conclusions and implications for the management of the results.

2. The ESDA and Its Application to the Tourist Sector

The tourist industry is characterised by a growing need for planning, which in its turn requires techniques capable of monitoring and analysing the flows of tourists [38]. One of the characteristics traditionally attributed to tourism is its territorial dimension, which is also characterised by an unequal distribution within and between destinations [27]. For this reason, finding out the distribution pattern of the data in a given territory is an essential task in the field of tourist management and planning.

The ESDA is a good tool for this purpose when no clear signs are present in the distribution patterns of a variable. The ESDA can be defined as a set of techniques which describe and visualise spatial distributions and at the same time identifies atypical locations (spatial outliers), discovers schemes of spatial association, groupings (clusters), or hotspots and also suggests spatial structures and other forms of spatial heterogeneity [39].

The importance of GIS in this process lies in the possibility which GIS o*ff*er for statistical analysis using graphs, which gives rise to what some authors term "scientific visualisation" [40].

By means of the exploratory study of spatial data, the so-called spatial e*ff*ects can be identified: autocorrelation or dependence and spatial heterogeneity. Spatial heterogeneity can be defined as the variation of relationships in space. It is determined either by the presence of structural instability caused by the lack of stability in the space of the behaviour of the variable under study or by the presence of heteroscedasticity [41]. The second of these e*ff*ects, the so-called spatial dependence or autocorrelation, is confirmed when there is a relation between what occurs at a given point in the space and what occurs in other points of the same space [42]. It is therefore in line with the contents formulated in the "first law of geography" of Tobler [43], according to which "everything is related to everything else, but near things are more related than distant things".

This study of dependence or spatial autocorrelation may result in three possible scenarios.

The first of these consists of the finding of the lack of spatial autocorrelation, i.e., when it is confirmed that the values of the variable are distributed at random in the territory analysed (random pattern of distribution).

The second of these scenarios is associated with the confirmation of positive spatial autocorrelation. This occurs when there is a direct relationship between similar values of a variable. It implies that the presence of a given phenomenon in a region means that it extends to other nearby regions [44]. In the specific case of tourism, the presence of this type of autocorrelation involves the presence of similar values of the tourist variable among nearby destinations, which means that a "contagion" e*ff*ect therefore exists [1].

Finally, the third possible scenario is when the presence of negative spatial autocorrelation is confirmed. This occurs when nearby destinations present very di*ff*erent values of a variable, or what amounts to the same thing, when the presence of a phenomenon in a region prevents or hinders its appearance in neighbouring regions [44]. In the specific field of tourism, this case generates what is known as the e*ff*ect of the "absorption" of a given geographical space [1].

Moreover, it must be taken into account that the study of spatial autocorrelation can be approached from two di*ff*erent perspectives: at a global level or a local level. The contrast from a global perspective pursues the objective of identifying spatial trends or structures in a specific geographical space, including the total of the observations of the variables in said space. In order to do so, the indicators proposed by Moran [45] and Getis and Ord [46] will be used. The main di*ff*erentiating characteristic of these contrasts from local contrasts is that they allow the summarising of a general scheme of dependence on a single indicator [41].

For its part, the local contrast of spatial dependence or autocorrelation is characterised because an indicator is calculated for each of the observation units, owing to which they allow the identification of in which of them higher (or lower) values than those expected in a homogenous distribution are concentrated. The most popular indexes for confirming the presence of local spatial autocorrelation include the local indicators of spatial association (LISA) proposed by Anselin [47] and the G_i family of statistics of Getis and Ord [46] and Ord and Getis [48].

Although both tests can be considered complementary, their approach can be clearly di*ff*erentiated. While the Getis–Ord G_i test concentrates on locating groupings of similar high or low values of the variable which are in accordance with the values of their neighbouring locations, Anselin's local I test expands these results to locate not only these two types of groupings but also those other entities presenting anomalous values compared with those taken by their neighbouring locations. This test may therefore give rise to five di*ff*erent results: groupings of high or low values with neighbouring locations taking similar values (HH or LL), high-value groupings surrounded by low values (HL), low-value groupings surrounded by neighbours with high values (LH), and finally entities in which no significant relationship can be identified.

As can therefore be seen, the results obtained by the application of Moran's local I test enriches the analysis and it is for this reason that this option has been selected to perform the analysis of local spatial distribution in this study.

On the other hand, the joint use of both types of contrasts, local and global, will allow the obtaining of exhaustive results in the spatial analysis carried out. In this sense, several authors point out that these are complementary techniques, as one of the main limitations of global autocorrelation tests is their incapacity to detect local spatial structures, hotspots or coldspots that may or may not extend to the global pattern structure [44,46,47,49–52].

At the same time, both types of test, local and global, have a common problem which must be correctly approached and resolved prior to the application of these techniques; deciding what will be the conceptualisation of the relationship of proximity, i.e., how to distinguish which entities are to be considered neighbouring. In order to do so, various criteria have been established, which in turn will vary depending on the approach used: the lattice perspective or the geostatistical perspective.

In the specific case of the geostatistical perspective, which will be the approach used in this research, the relationship of proximity can be established by means of any of the following criteria: inverse distance, square inverse distance, and fixed distance band. In general terms, the fixed distance band criterion is the most frequently used in the existing literature [53,54]. Authors such as Sánchez et al. [28] point out that it should be taken into account that each of the criteria listed establishes a relationship of proximity which has a significant e*ff*ect on the results obtained; owing to this it is necessary to be cautious and carry out di*ff*erent tests before deciding on a criterion so as to ascertain which is best suited to the study area.

With regard to the possibilities of the application of these techniques to the specific field of tourism, it should be pointed out that this will allow the identification of the distribution pattern followed by the variable in the area analysed, with the implications for tourist planning which these findings involve. In this way the identification of a positive spatial autocorrelation pattern in a given region indicates the existence of a contagious e*ff*ect among neighbouring destinations, which would make possible the existence of a common strategy for tourist development in neighbouring regions. At the same time, the existence of spatial autocorrelation at a local level will allow the identification of groups of municipalities with common characteristics regarding their tourist situation and therefore with similar needs as to the designing of strategies for future development.

The following section provides a series of characteristic features of the evolution of the tourist sector in Extremadura together with a reference to some studies carried out in this region which allow the reader to obtain further knowledge on the tourist situation of the region.

3. Case Study: Space and Tourism in Extremadura, Spain

Extremadura is a Spanish region in the southwest of the Iberian Peninsula which consists of the two largest provinces in Spain: Cáceres and Badajoz. The total surface area of the region is 41,633 km^2. Its economy has traditionally been characterised by a strong dependence on agro-forestry activities and by being that of the Spanish region with the lowest gross domestic product (GDP) per capita [55]. Moreover, this is combined with a high rate of unemployment which was 19.68% in the third quarter of 2019 [56]. Given this situation, the region has been obliged to create new productive activities to provide economic development by means of the creation of wealth and employment and has seen in the development of tourist activities a good ally to achieve this.

The potential of tourist activities for contributing to economic development, reducing regional asymmetries, creating employment, and generating positive external elements affecting other economic activities has been traditionally accepted [57]. This characteristic becomes particularly relevant in the case of regions which owing to a geographically isolated location see in the tourist sector their only possibility of growth [58] by means of the diversification of the existing incomes.

It is as a result of all this that at a European level a series of programmes have been developed with the ultimate aim of the diversification of economic activities in areas with a low level of economic development. The LEADER, LEADER II, and PRODER programmes are a good example of this, and their impact is particularly noteworthy in the region under study, Extremadura.

The result of these subsidies has been the rapid growth of the accommodation capacity of the region, especially in the case of rural lodgings. This growth has not been matched by a parallel increase in the number of visitors, which has therefore created considerable imbalances which must be analysed exhaustively in order to understand the current situation of the tourist sector in the region [5].

In the year under study, the region had a total of 1296 accommodations that offered a total of 38,940 places. Of these, a total of 19,837 places were offered by the 471 hotel accommodations installed in the territory, the rest, 19,103 places, are the result of the offer of beds made by the 827 non-hotel accommodations located in the region in that year according to data provided by the Tourism Observatory of Extremadura. We find, therefore, a region that keeps a good balance between the number of places offered by hotel and non-hotel accommodation. However, the own peculiarities of extra-hotel accommodations, which offer on average a smaller number of places, entail a greater representativeness with respect to the number of accommodations, which in turn allows a better distribution throughout the territory.

The studies which have been carried out to date in order to find out the pattern of distribution of tourist activity in this space have taken as a reference variable the number of beds available, with these studies being limited to the analysis of the beds offered by rural tourism lodgings. In this way it has been possible to confirm the existence of different clusters of municipalities offering a high number of beds in comparison with what would be expected in a homogeneous distribution of the variable [1,5,25,28].

There is no doubt that these studies have helped to stress the importance of the analysis of spatial distribution patterns of tourism in the region as their results confirm the existence of groups of municipalities with a similar accommodation capacity and which can therefore develop common strategies of development and planning. As is stressed by the authors themselves, the existence of these similarities among territories allows a bid for joint policies to cover extensive proximal territories [5].

However, up to now, the findings on the spatial behaviour of the tourist supply in the region have only served to emphasise the need for carrying out exhaustive spatial analyses of tourist activities and in particular to provide information on the behaviour of the demand from travellers to the region and its adjustment with respect to the places offered.

One of the common conclusions of the studies carried out to date on the distribution of the beds for tourists in the region is that the expansive policies used as strategies for developing the sector have given rise to unequal growth between the supply and the demand, with the result being the generation

of imbalances in the activity [1,5,25,28]. This situation of imbalance appears to be preventing these beds from fulfilling their function of generating the economic growth for which they were created.

This imbalance may be represented by one of the variables habitually used in order to characterise the satisfactory performance of tourist activities, the occupation level. The occupation level of an accommodation establishment can be defined as the quotient between the beds which have actually been occupied in relation to those available. This variable can therefore be considered a good proxy indicator of the level of adjustment between the supply of and the demand for tourist activities in a given territory. The spatial analysis of the occupation level variable will allow us on the one hand to find out whether there is a general pattern of the grouping of the variable in the space and on the other to discover groups of lodgings showing similar behaviour in the space, i.e., having a satisfactory adjustment in their supply of beds (hotspot) or on the contrary, poor adjustment between supply and demand (coldspot).

The importance of the findings which we aim to discover with the performing of this analysis lies in the fact that as a consequence of the same it will be possible to group together those accommodation establishments which are near to each other and show similar behaviour; this in turn will allow the generalisation of the tendency identified in the territory in which they are located. In short, the groupings identified by this kind of analysis will permit the regional administration to establish common development strategies, making use of the synergy e*ff*ect and the consequent scale economies, and designing joint planning to cover extensive territories with a similar characterisation and initial situation.

Given that the objective of this research is to help the regional administration to identify territories in which tourist lodgings are located that have an equal occupation level di*ff*erent from that to be expected in a homogeneous distribution of the activity, we decided to use as a reference the territorialisation created by the regional administration for the strategic planning of the region. Since the establishment of the Extremadura Observatory Tourism in 2013, the regional administration responsible for tourism has opted to use a territorial division that allows combining tourist regions that, because they have similarities in terms of their portfolio of tourism products, have been considered optimal to perform a joint analysis. It should be noted that this division is carried out on the basis of knowledge of each of the regions subject to territorialization but that it is not based on any study that has used ESDA techniques that have allowed us to verify the spatial grouping of accommodation whose behavior is similar and di*ff*erent from that expected under a homogeneous distribution pattern, and that therefore, supports the feasibility of using joint planning that allows optimizing the results of the policies implemented for joint development.

In the same way, the sample used to perform this analysis is that proposed by the Extremadura Tourism Observatory and guarantees the correct representation of the supply of beds existing in each of the territories used. Specifically, for the reference month and year, the sample consisted of a total of 270 lodgings that o*ff*ered 15,966 places in the region. According to the total accommodation capacity indicated above formed by 38,940 places distributed among a total of 1298 accommodations, the sample obtained represents 20.8% of the establishments and a total of 41.0% of the total places. In addition, it should be noted that, as specified in the di*ff*erent reports published by the Tourism Observatory, the representativeness of the sample was determined for each of the territories, and given that sample is the sample used by the agency that is responsible for carrying out the o*ffi*cial statistics of the region, and it is confirmed, the selected sample is considered representative of the tourist activity of Extremadura.

Figure 1 shows both the distribution of the sample of accommodation establishments used and the location of each of the territories which will subsequently be analysed.

Once the sample to be analysed has been presented, the following section explains in detail the methodology used to achieve the proposed objectives of this research.

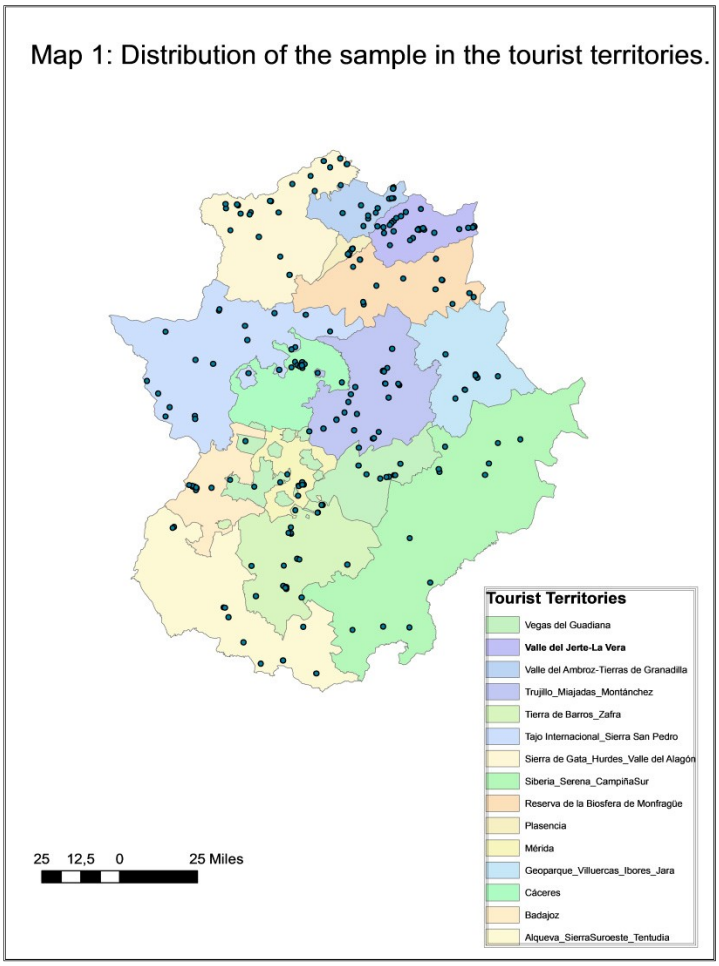


Figure 1. Distribution of the sample in the tourist territories. Source: Own material from calculations made with ArcGIS ver. 10.3.

4. Methodology

This study fits in with the techniques of the ESDA, concentrating particularly on the analysis of the phenomenon of spatial dependence or autocorrelation. In order to achieve this we have used the ArcGIS software in its 10.3 version, which from a geostatistical perspective allows the analysis of spatial dependence or autocorrelation by means of the most commonly used indexes.

The variables to analyse are on the one hand the beds offered by the various types of accommodation establishments in the region of Extremadura, and on the other hand the occupation level of the region, using for the purpose a sample consisting of a total of 270 tourist lodgings which provided their occupation details to the Extremadura Tourist Observatory in July 2015.

The month and year selected for carrying out this study depend on a strategic criterion within the general objective pursued by the authors. In this sense it should be emphasised that this study is part of a more extensive research project which aims to analyse the spatial patterns of distribution over a three-year period from 2015 to 2017. In this way the decision was made to perform the analysis using the first year of reference and within this year, July was chosen for being the first month of the quarter (the third of the year) recording the highest occupation levels in most of the territories to analyse. Also, this month is characterized by being among the two that present the highest occupancy, July and August, which has a lower variability. Once the reference quarter has been selected, the objective is to see which month meets the requirement to position itself as a month that presents a good performance for most of the territories under analysis and, in turn, does not present a great variability between the different months under study. For this, the study carried out on tourist seasonality between the

different territories is taken as a reference [59]. This study analyzes, among other aspects, the tourist density for the different tourist territories in which the region is divided and it is obtained that although August, together with the month of July, are the months that present maximum values for the greater part of the territories, August is also established as a minimum month for any of them; the same not happening with the month of July. Therefore, although the final objective is to analyze the tourism efficiency pattern in the territory in the entire annuity, it is decided to use the month of July to start as a basis for analysis and confirm if, depending on the results obtained after this first analysis between the different territories, it is worth extending the analysis to an annual scale.

The findings of this research therefore not only generate exhaustive knowledge of the distribution pattern of the supply and its satisfactory adjustment to the tourist demand in the region during the month and year selected but also allow the laying down of the methodological foundations for the analysis of the remainder of the period of time considered.

Within the range of the possible variables available for measuring tourist activities, the decision was made to select the two variables considered most suitable for the characterisation of tourist activities as a whole, as in this way the distribution pattern of the supply can be analysed and in turn, the satisfactory adjustment between supply and demand measured by the occupation level of each of the lodgings.

The study of the autocorrelation or spatial dependence of the variables mentioned in the territory of Extremadura is moreover analysed from a double perspective: global and local. The objective of the contrast of spatial dependence in the global perspective is to identify spatial trends or structures in a specific geographical space. The indicators proposed by Moran [45] and Getis and Ord [46] are used for this purpose. These indicators are the first formulations proposed in the literature as statistical measurements of the spatial autocorrelation effect. Moreover, they are characterised by their capacity to summarise a general outline of dependence in a single indicator [44].

Both contrasts assume an objective statistical criterion which allows the confirmation or rejection of the presence of trends or spatial structures in the distribution of a variable. In both cases, the null hypothesis to confirm is the lack of spatial dependence, i.e., the randomness of the distribution of the variable in the territory selected.

Moran's I test (1948) is given by the following, Equation (1):

$$I = \frac{N}{S_0} \frac{\sum_{ij}^{N} w_{ij} \times (y_i - \overline{y}) \times y_j - \overline{y}}{\sum_{i=1}^{N} (y_i - y)} \quad i \quad j, \tag{1}$$

where

w_{ij} is the element of the matrix of spatial weights corresponding to par (i, j);
S_0: the sum of the spatial weights $\sum_i \sum_j w_{ij}$;
$\overline{y}$: the average or expected value of the variable;
N: the number of observations.

Once one proceeds to standardisation by rows of the matrix of spatial weights $S_0 = N$, the statistic I takes the form of the following, Equation (2):

$$I = \frac{\sum_i \sum_j w_{ij} \times (y_i - \overline{y}) \times y_j - \overline{y}}{\sum_{i=1}^{N} (y_i - y)}. \tag{2}$$

According to Cliff & Ord [60], when the sample is large enough this statistic is distributed as a standard rule N (0.1). The inferential process uses the standardised values (Z) of each of them, which are obtained by the quotient between the difference of the initial value and the theoretical average and the deviation, i.e.,

$$z = \frac{I - E[I]}{SD[I]}. \tag{3}$$

The values obtained by the test will be interpreted as follows: non-significant values of test I will involve the non-rejection of the null hypothesis of the random distribution of the variable in the space studied. For their part, significant values of the variable and positive values (values exceeding 1.96 at a significance level of 5%) will indicate the presence of positive spatial autocorrelation, i.e., they will identify values of the variable (high or low) specially grouped in the space to a greater extent than would be expected if they were following a random distribution pattern. The significant and negative values of the variable (values lower than −1.96 at a significance level of 5%) will reflect the existence of negative spatial autocorrelation, or what amounts to the same they will identify a non-grouping pattern of similar values (high or low) of the variable which is higher than normal in a random spatial pattern.

In order to complete the global analysis of the distribution of the variables, the family of indicators proposed by Getis and Ord [46] is also used. They stand out by using a criterion which is different to those used up to now to measure spatial autocorrelation based on the distance or spatial concentration statistics.

The calculation of the statistic requires the definition of a critical distance (d), as from this distance a radius of influence is established from which it is determined which units are neighbours to others depending on whether they are within the radius of influence determined by the critical distance.

It is given as follows:

$$G(d) = \frac{\sum_{i=0}^{n}\sum_{j=0}^{n} w_{i,j}(d)y_i y_j}{\sum_{i=0}^{N}\sum_{j=0}^{N} y_i y_j} \text{ for } i \quad j, \tag{4}$$

where two pairs of spatial units i and j are neighbours if they are found within a determined distance d, taking the w_{ij} value of 1 when this is so or 0 when it is not.

The statistical significance is checked by means of the standardised statistic Z which is distributed at an asymptotic level according to a rule N (0.1). The interpretation of this test in those cases with statistical significance will be as follows: a positive (or negative) z value exceeding 1.96 for the absolute value will indicate a tendency to the concentration of similar high (or low) levels.

One of the main limitations of global autocorrelation tests is they are incapable of detecting local spatial structures, hotspots or coldspots, which may or may not extend to the global pattern structure [41,46–52]. It was in order to overcome this limitation that local spatial autocorrelation tests were developed. The objective of these tests is the detection of particularly high or low values (hotspots or coldspots) of a variable in comparison with its average values. They are characterised by being calculated for each of the spatial units to analyse, owing to which they allow the detection of those concentrating higher or lower values than what can be expected in a homogeneous distribution.

The analysis of local spatial autocorrelation may present two different scenarios in contrast to global spatial autocorrelation as is pointed out by Vayá and Suriñach [52]. In the first place, it may occur that in a specific space as a whole a distribution pattern of the concentration or dispersal of values at a global level is not detected and indeed there are small clusters in which high (or low) values of the variable are concentrated. Secondly, it may also occur that given the existence of a global distribution pattern, some spatial units contribute to a greater extent to that global indicator.

For this reason, the analysis of autocorrelation at a local level constitutes a good complement to the study of global distribution.

The local indicators of spatial association (LISA) proposed by Anselin [47] and the G_i family of statistics of Getis and Ord [46] and Ord and Getis [48] are the most frequently used indicators for the study of spatial autocorrelation at a local level. In this study, as is explained in section two, we decided to use the LISA maps of Anselin [47] as a criterion as we consider that the results of this test give a wider interpretation.

Anselin [47] proposes a set of local indicators of spatial association with the objective on the one hand of the determination of significant local spatial groupings (clusters) and on the other the detection of pockets of spatial instability, understood as the presence of atypical values.

Among the indicators proposed by the author, Moran's local I_i statistic stands out; its equation is as follows:

$$I_i = \frac{z_i}{\sum_i z_i^2/N} \times \sum_{j \in j_i} w_{ij}\, z_j, \quad (5)$$

where z_i is the standardised value of the spatial unit i and j_i the set of spatial units proximal to i.

According to a random distribution hypothesis, the probability of the statistic is:

$$E_A(I_i) = -\frac{w_i}{N-1}, \quad (6)$$

where w_i is the sum of all the elements corresponding to the row of unit i.

The hypothesis assumed is that the standardised I_i statistic is distributed as an $N(0.1)$ rule.

The standardised statistic is interpreted as follows: a high positive value (z-score) exceeding 1.96 at 5% of significance will indicate the presence of clusters of high or low values of the variable. For its part, a significant negative value (less than −1.96 at 5% of significance) indicates the existence of spatial outliers.

For each of the tests listed up to now, and as has been revealed in section two of this study, it is necessary to choose a proximity criterion that adjusts satisfactorily to the particularities of the area under study. In order to be able to make this choice, various tests have been carried out with each of the three possible criteria in accordance with the geostatistical perspective used. After they were carried out it was decided to use the criterion most frequently followed in the literature to date, the fixed band distance criterion; the distance used is that established by the programme by default to ensure that all spatial units have at least one neighbour, 15.79 miles.

Once the different contrasts to be used in this study have been presented, the following section gives the main results obtained from the analysis of spatial autocorrelation at both a local and global level of the variables of the beds available and the occupation level of the region of Extremadura.

5. Results

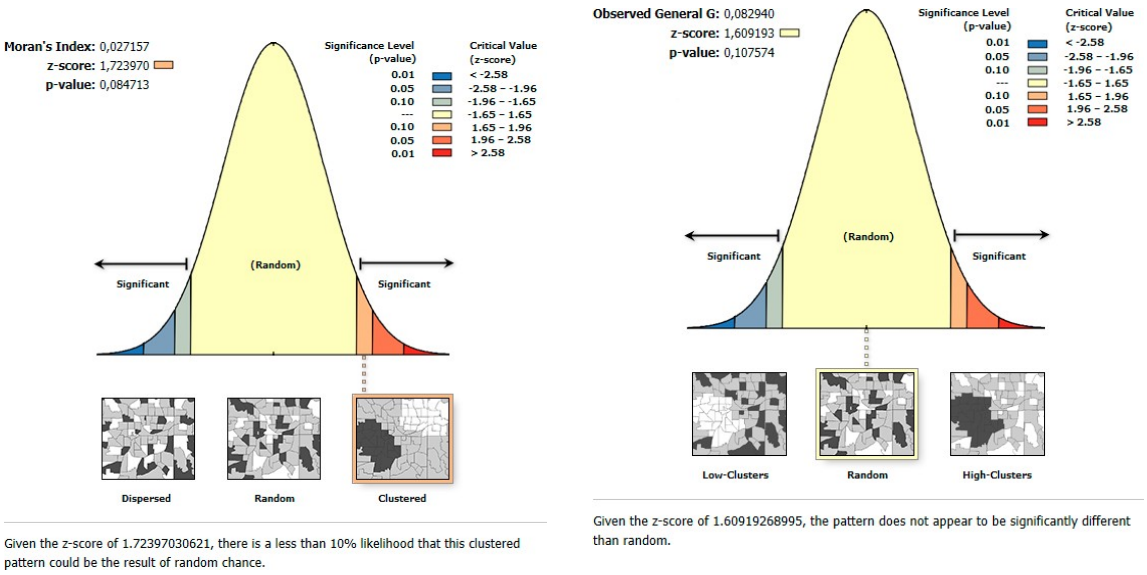
As has been mentioned, the final aim of this research is to determine the level of adjustment between tourist supply and demand in the region of Extremadura, describing the distribution pattern of this region and identifying groupings of establishments in a similar situation. In order to do so it uses a sample consisting of a total of 270 tourist establishments, which in July 2015 provided their occupation data to the Extremadura Tourism Observatory. Given the different data provided, it was decided to use two of the most representative variables with the aim of measuring tourist activities: on the one hand, the total number of beds offered by the various accommodation establishments during the period analysed, and on the other the average occupation level of each establishment (as an indicator of a satisfactory balance between the beds offered and those actually occupied).

Moreover, the study is carried out from a double perspective: on the one hand the existence of a global pattern of distribution of the variables being studied is contrasted and on the other the possible existence of local distribution patterns is examined. For the first objective we used the two most commonly used indexes, Moran's global I test and the Getis–Ord general G (d) statistic.

The results obtained for the first variable analysed, the number of beds available, can be seen in Figure 2.

As can be seen in graph 1, Moran's global I statistic takes a value of 0.0271, with the score z being equal to 1.7239, owing to which at a significance level of 10% we can affirm that a pattern exists of the concentration of the values of the variable in the space. It is therefore confirmed that there is a slight tendency towards the concentration of the beds available in the space studied.

For its part, the Getis–Ord general G (d) test gives a value of the statistic G of 0.0829, which gives a score z of 1.6091, owing to which we cannot reject the null hypothesis of the random distribution of the variable in the space at a confidence level of 95%. In other words, with the results obtained in this test we cannot affirm that the beds for tourists are not distributed at random in the space analysed.



(a) Moran`s Global I test **(b) Getis-Ord general G(d) test**

Figure 2. Results of Moran's gGlobal I Test and the Getis–Ord general G (d) test on beds available in Extremadura. Source: Own material from calculations made with ArcGIS 10.3.

From the results obtained for each of these tests the lack of coincidence can be appreciated; this may be due to the weak relationship of the variable which means that this relationship is not maintained in all the tests carried out. In turn, this weak relationship may be a sign of an equal bid on the part of the public administration of Extremadura for the development of accommodation infrastructures apart from the resources and the tourist potential of each tourist territory in the region.

On the other hand, the study carried out up to now only takes into account the analysis of the beds at a global level, i.e., considering the whole of the target territory. The fact that a global distribution pattern is not identified, or that if it is identified it is weak, does not imply that it is impossible for there to be groups of lodgings at a local level with values of the variable which are very different from the average values of their neighbours. For this reason, Moran's local I test has been calculated; this will allow us to obtain further knowledge on the distribution of beds for tourists at a local level. The results obtained can be observed in Figure 3.

In view of Figure 3, it can be concluded that certain areas exist in which groups of accommodation establishments offer a higher number of beds than those located in neighbouring areas. In the case of the two main towns of the region, both of which are provincial capitals, the existence of several accommodation establishments with high values of the variables in comparison with the value of neighbouring locations can be observed. In these two locations, therefore, one can speak of the existence of two clusters of high values of the variables, i.e., of two clusters in which the accommodation establishments offer a higher number of beds than those located in neighbouring areas.

In the same way, this technique will allow the identification of atypical spatial entities, i.e., those with a high (or low) value of the variable which are surrounded by low (or high) values. In this case, one can observe the existence of three accommodation establishments with a high number of beds compared with the average offered by neighbouring establishments. In turn, there are also two accommodation establishments which offer a small number of beds and are surrounded by neighbouring establishments offering on average a higher number. Finally, two isolated lodgings were also identified with a high number of beds in comparison with the average. In all cases, the results obtained will not be taken into consideration in the analysis performed as we are here concerned with findings related to isolated accommodation establishments, which although they are significant in

terms of the administration of the same, do not allow the forming of accommodation groups which suggest that the results can be extended to the entire territory.

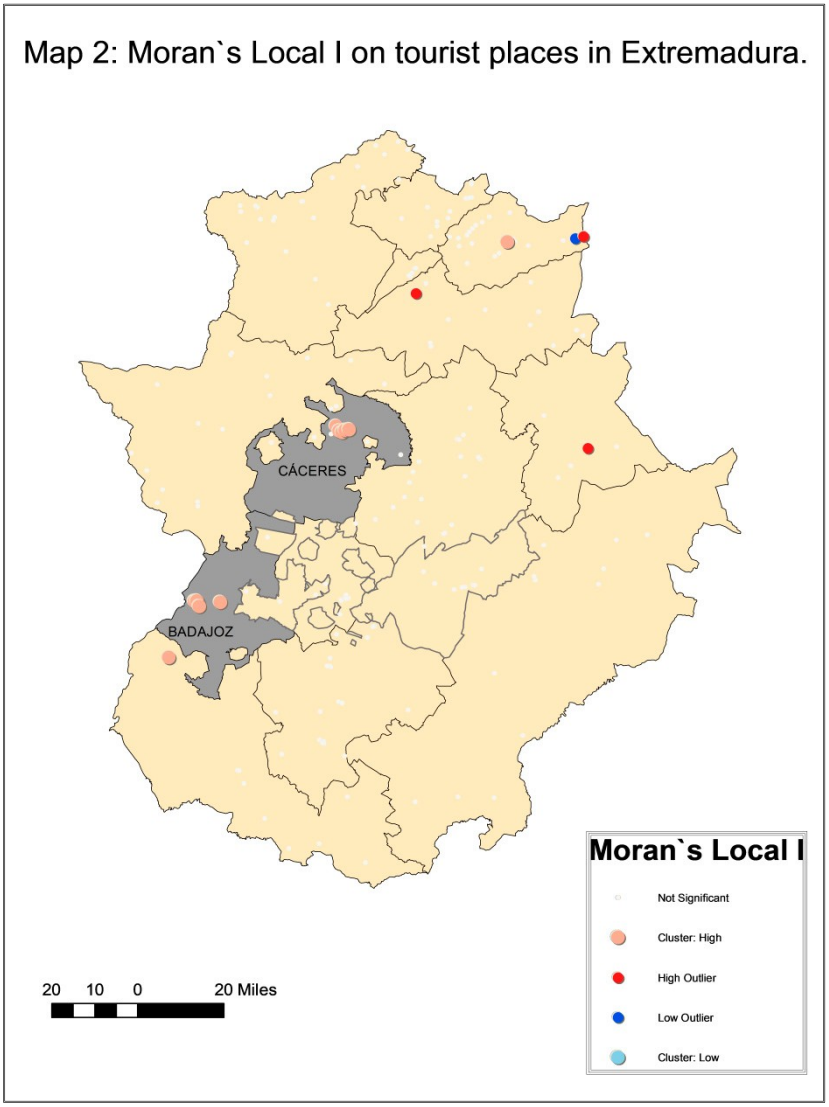


Figure 3. Moran's local I for tourist places in Extramadura. Source: Own material from calculations made with ArcGIS 10.3.

Once the analysis of the distribution of the variable of the beds available in the territory of the region has been completed, it can be concluded in the first place that there is a slight tendency towards the concentration of the values of the variable in the total space of the region. Secondly, the existence is confirmed of two groups of accommodation clusters offering a high number of beds in comparison with the average for the territory and which are located in the two main centres of population: Badajoz and Cáceres.

Subsequently, we proceed to repeat the analysis performed for the second variable which is the subject of this study, the occupation level, which will allow the identification of the level of adjustment existing between supply and demand for the region of Extremadura.

Figure 4 shows the results obtained for Moran's global I test and the Getis–Ord general G (d) test.

As can be seen in Figure 4, statistic I has a value of 0.1594, which means a score *z* of 8.7278; it can therefore be confirmed that at a significance level of 1% there is a pattern of the concentration of the

variable in the space. In other words, at a confidence level of 99% it is confirmed that the similar values of the variable have a tendency towards concentration in the space.

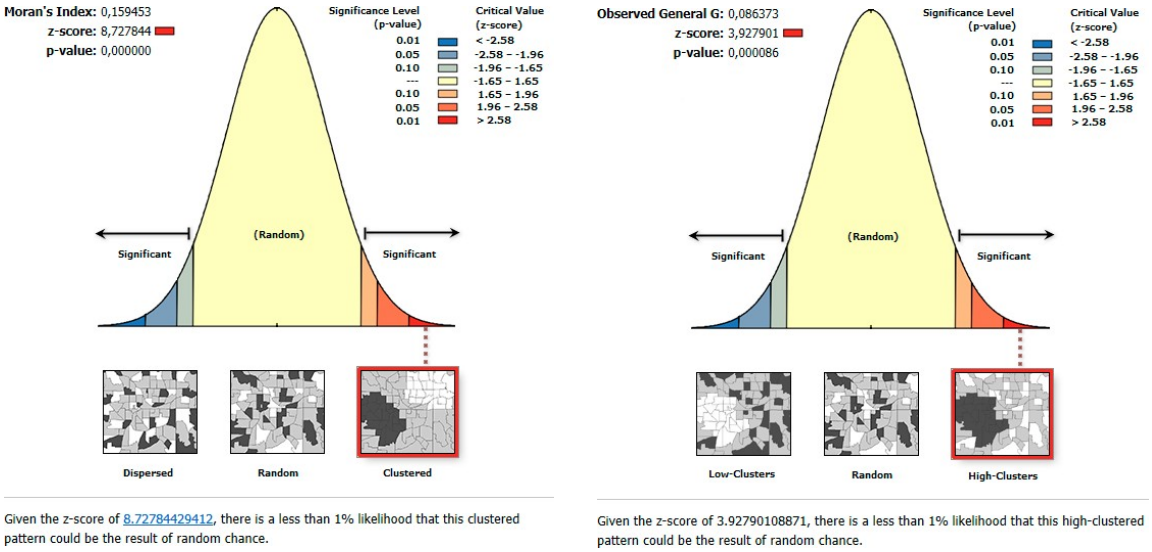


Figure 4. Moran's global I test and the Getis–Ord general G (d) test on the occupation level in Extremadura. Source: Own material from calculations carried out with ArcGIS 10.3.

For its part, the Getis–Ord general G (d) test gives a statistic with a value of 0.0863, with the score *z* being 3.9279, and a p-value of practically zero. This implies that a significance level of 1% confirms that the variable tends to concentrate in the space and moreover is concentrated at high values.

As we can see, both results coincide and confirm the existence of a global pattern of the concentration of the occupation level variable in high values of the same. However, the contrast of the two results obtained with respect to the global distribution of the variables allows us to confirm the initial suspicions regarding the results of the expansionary growth policies used as development strategies in the region. These have allowed the tourist places in the region to have a practically homogeneous distribution pattern, thus only obtaining confirmation of a weak tendency to concentrate in the high value space that is not confirmed in the totality of the tests performed. On the other hand, the results obtained for the occupation level do confirm the existence of a strong tendency to group high values in the region, which suggests the existence of a serious imbalance in terms of the efficiency of these places that should be studied in an exhaustive way with the objective of being able to create strategic lines that fit the reality of each of the territories in which the region is divided, with the ultimate goal of achieving sustainable tourism development throughout the territory.

The local analysis of the variable by means of Moran's local *I* test allows determining whether groups with similar behaviour are created and their locations. The results of this analysis can be seen in detail in Figure 5.

In view of the results obtained, the presence of different groupings of spatial clusters with similar values as to the occupation level is confirmed, i.e., they show a high or low level of adjustment between supply and demand in comparison with the average value to be expected in the space analysed.

Firstly, we can observe the presence of three clusters of high values of the occupation level variable located in the towns of Badajoz, Mérida, and Cáceres. These three territories are therefore characterised by the presence of a high number of lodgings with higher occupation levels than would be expected from the average value of their neighbouring territories. If we take the occupation level as a proxy indicator, we find that these are the three territories in the region with the best adjustment between supply and demand.

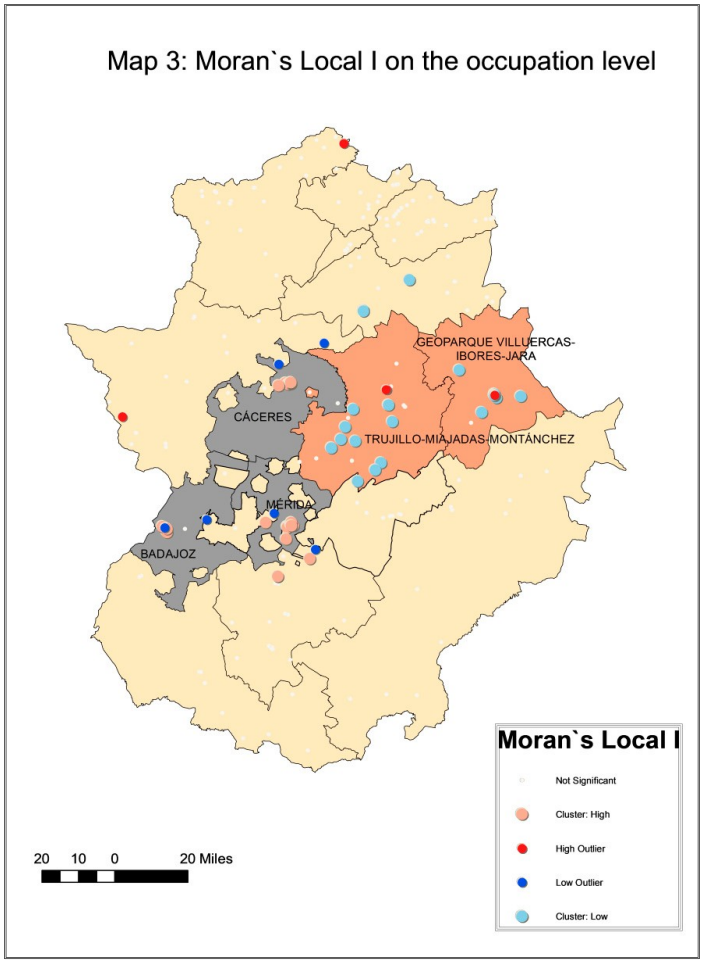


Figure 5. Moran's Local I for the occupation level. Source: Own material from calculations carried out with ArcGIS 10.3.

For their part, the presence of two clusters of low values is observed in the territories of Trujillo-Miajadas-Montánchez and the Villuercas-Ibores-Jara Geopark. In these territories, therefore, we find a set of accommodation establishments with the common characteristic of a low occupation level with regard to the average value to be expected in the month and territory analysed. In accordance with the above reasoning, these two territories are those with the worst adjustment between supply and demand, owing to which they must concentrate on developing strategies allowing the increasing of said occupation level so that the creation of the existing beds for tourists fulfils the mission of creating wealth and employment in the territories analysed.

Finally, the presence of di*ff*erent spatial outliers and outlier types is observed, such as high outliers and low outliers. As can be seen, these are not grouped together in any of the territories in question but are rather isolated cases of accommodation establishments with a casuistry causing this situation owing to specific management, or to obtaining better or worst results than those to be expected in the territory in which they are to be found. Although these results could represent a valuable output for each specific accommodation establishment, they go beyond the scope of the global objective of this research, which consists of the location of groupings, which as their situation is similar, can help the administration to characterise them, and as from this starting point to create common lines of strategy which allow the optimum tourist development of each territory analysed.

As a general conclusion of the distribution pattern of the occupation level variable, it should be stressed that in contrast to what occurred with the beds available, on this occasion a strong tendency to the concentration of high values in the space can be observed. This conclusion is confirmed with the

existence of various clusters of high and low values, which requires an analysis of the same before carrying out any task of tourist planning in the interests of achieving more e*ffi*cient management.

6. Discussion and Conclusions

The analytical possibilities of the inclusion of GIS for the application of the techniques of spatial statistics have opened up many options for achieving highly exhaustive analyses in the territories and their spatial dimension. By means of the application of said techniques it is possible to identify spatial distribution patterns of the variables under study in a given territory and also to identify groupings of entities with a similar or di*ff*erent behaviour to that which could be expected in a homogeneous distribution of the variable. The main advantages deriving from the identification of these clusters is that they will allow the joint planning of more extensive territories, in which owing to their characteristics it is possible to analyse the initial situation and at the same time the existing needs to establish a common goal, making use of the advantages of this joint planning regarding management.

It is for this reason that more and more studies are concentrating on analysing the distribution patterns of the variables related to tourism in the space, with the aim of improving the planning and management of the territory. These studies are characterised by being essentially focussed on demand, concentrating their e*ff*orts on studying the distribution in the space of the accommodation capacity of the territory.

This study expands this perspective, completing the analysis of the supply with a detailed analysis of the distribution of the occupation level, taking this last variable as a proxy indicator of the satisfactory level of adjustment between supply and demand in the territory. By means of this analysis therefore, the objective of getting to know the e*ffi*ciency of each territory with regard to the hotel beds o*ff*ered is achieved, identifying accommodation groupings with similar characteristics in the territory and which therefore can be examined for correct planning and management in a joint manner.

Moreover, this analysis also presents the novelty, regardingthose tudied on the region previously, of using a geostatistical approach which allows the using as an analytical unit the maximum level of territorial disaggregation possible, the location of the establishment itself. As a result, the contributions of this research allow on the one hand exhaustive knowledge of the distribution pattern of the two variables which are the subject of study in the month of reference used, and on the other hand the laying down of the methodological foundations allowing their repetition at di*ff*erent moments in time, allowing in this way the considerable enriching of the results obtained. In this sense, and after performing various tests in accordance with the characteristics of the sample used, the decision was taken to consider as the most suitable neighbourhood criterion a fixed band distance of 15.79 miles.

With regard to the main results obtained from this study, it should be emphasised that the beds available in the total territory analysed have a weak tendency towards the concentration of values in the space. However, given that this relationship is not significant in the Getis–Ord general G (d) test, it cannot be confirmed whether this tendency is the result of the concentration of high or low values of the variable.

From a local perspective, the presence has been detected of two clusters of high values in the main population centres of the region, i.e., in the towns of Cáceres and Badajoz.

The analysis of the global distribution of the occupation level variable identifies a strong tendency towards concentration in the space, and moreover this spatial concentration occurs with high values. It is therefore a variable with the characteristic of a contagion e*ff*ect which allows the increase of a variable in a given space, favouring also the value taken in its proximal locations, which is a clear indication that joint management has the possibility of benefitting a wider extension than that of the territory itself.

In relation to the study of the distribution of the occupation level at a local scale, the presence is identified of three spatial clusters of high values located in Badajoz, Cáceres, and Mérida. These territories are therefore characterised by concentrating a high number of accommodation

establishments with high occupation levels in comparison with what would be expected in a homogeneous distribution of the variable in the territory.

With regard to the administration of this result, it must be taken into account that although these three territories stand out as being the most e*ffi*cient in relation to the beds they provide, the result only implies that they have a good initial situation as the average occupation level of each of these territories in the month analysed varies from 38.2% in Badajoz, 40.2% in Cáceres, and 60.7% in Mérida as has been calculated from the data available from the Extremadura Tourism Observatory. In all cases it can be observed that there is clearly room for improvement, and that there is no evidence to assume that the same are exceeding the maximum load capacity to ensure sustainable management, owing to which said territories should in the first place find out whether this situation remains constant over time. Secondly, the regional administration should analyse the characteristics of the o*ff*er of tourist products, which at the moment places them in this position, and finally analyse the possibilities of the territory in accordance with their allocation of resources so as to improve the initial situation.

On the other hand, the analysis has also allowed the identification of two accommodation clusters with low occupation values in relation to the figures for accommodation in their neighbouring locations; these are the territories of Trujillo-Miajadas-Montánchez and the Villuercas-Ibores-Jara Geopark. The average occupation levels of these territories are 20.7% and 16.7%, respectively. These figures are below the regional average, which is 25.8% of the beds available for the month being studied.

We are therefore concerned with two territories with a demand deficit which they must resolve if the beds they o*ff*er are to contribute to the creation of wealth and employment. It would be recommendable to perform an exhaustive analysis on the supply of the type of tourist product these territories currently o*ff*er with the aim of determining whether there is a strong dependence on any specific tourist type with a marked seasonality which is causing this situation. If necessary, the existing o*ff*er should be diversified with the aim of palliating this deficit and improving the results. In short, once the similarity of the initial situation has been detected, the analysis of the reasons will give rise to a series of common needs which will be those allowing the articulation of the lines of action to bring about the more e*ffi*cient management of their resources.

To conclude this analysis of the results, it should be pointed out that both in the local analysis of the distribution of the beds available and in the respective occupation level a series of accommodation establishments appear which represent both clusters of similar values (HH or LL) and an outlier of HL and LH values. These results have not been detailed among the main conclusions of this study, as all of them are found in the space in isolation, owing to which said findings, although they may constitute a valuable output for the managers of these establishments, are beyond the scope of this study, the purpose of which is the comprehensive (or global) management of the territory.

One of the main limitations of this research is that the results obtained are restricted to the timeframe used, July 2015. In order to resolve this shortcoming, we propose as a future line of research the extending, by means of the repetition of the methodology proposed, of the results to a wider timeframe, preferably annual to limit the possible e*ff*ects of seasonality in each of the territories, so as to find out whether the clusters identified are maintained throughout the whole of the tourist season, and also the possibility that new associations may appear so as to expand the knowledge on the region of Extremadura. Likewise, it would be enriching to complete the analysis of the tourist reality of the region and be able to design properly adapted development strategies, disaggregate the results obtained according to the type of accommodation, taken into account variables such size, quality, the profile or ownership, among others, to eliminate the possible e*ff*ects that the peculiar characteristics of the results might be introducing into each one of them.

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CAPÍTULO 3

A SPATIAL ANALYSIS OF INTENSITY IN TOURISM ACCOMMODATION: AN APPLICATION FOR EXTREMADURA (SPAIN)

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Article

A Spatial Analysis of Intensity in Tourism Accommodation: An Application for Extremadura (Spain)

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Abstract: There is a general belief that the distribution of tourist activity in space does not respond to a random pattern, so having a thorough knowledge of said activity will require analyzing and understanding its distribution pattern. At the same time, the adequate planning of this sector requires exhaustive knowledge, on the one hand to be able to enhance the positive effects of concentrations in the space, and on the other hand to avoid those possible adverse effects. Therefore, various studies focus on providing information on the random pattern of these activities, especially in developing destinations with a great interest in generating a model of sustainable tourism development. This paper aims to contrast the results achieved by previous studies at the destination while describing the pattern identified through the use of alternative statistical techniques rather than those commonly used. In particular, an intensity function is estimated using three different methods: quadrant counting, K-function, and kernel smoothing. The results achieved allow the identification of the areas with the greatest tourist intensity while describing the practical implications of the results achieved.

Keywords: spatial point patter (SPP), spatial homogeneity; kernel density; quadrant counting; Ripley's function; accommodation; tourist planning; Extremadura

1. Introduction

The increase in the importance of spatial interaction between social sciences can be reinforced by, among other methods, the greater availability of georeferenced data together with the development of specific software including modules allowing the statistical analysis of said data (Anselin and Florax 1995). As a result of the combination of these factors, the analysis of space begins to acquire special importance among the social sciences, highlighting tourist activities due to the special relationship with their being carried out in a given territory.

The location of any tourist company in a given space favors aspects as essential for its satisfactory progress, such as the amount of resources available, the level of occupation, seasonality, or competitive intensity, among others (Cawley and Gillmor 2008; Hall 2011). In addition, it can also be influenced by factors such as accessibility or the offer of complementary accommodation or services (Martín et al. 2018).

It should be taken into account that tourist activities strongly depend on the assets and attractions found in specific locations, as tourism is a sector with a strong tendency towards spatial concentration (Carreras Verdaguer 1995), which therefore encourages the emergence of so-called agglomeration economies.

Agglomeration economics means the benefits obtained by companies as a result of being located near others, and there may be two types, location and urbanization economies (Beaudry and

Schi*ff*auerova 2009; Hoover 1936); the benefits are the so-called geographic spillover e*ff*ects. Since the pioneering work on the subject by Marshall (1920), Ohlin (1935) and Hoover (1936), a series of investigations have proliferated, which, although they continue to have greater weight among the manufacturing industry, have also begun to gain strength in the services sector. This has allowed knowledge of the benefits that space grouping entails for this sector (Wernerheim and Sharpe 2005; Kolko 2010; Jackson and Murphy 2002; Sölvell et al. 2008).

The main consequence of the formation of agglomeration economies is that they generate a series of spillover e*ff*ects, which can be both positive and negative with respect to tourist activities, and which must be taken into account in order to properly understand how these activities operate. Geographical spillover e*ff*ects are the indirect or unintended e*ff*ects that the industry of a tourist region has on the tourist flows of other nearby regions (Yang and Fik 2014; Yang and Wong 2012).

Given all of the above, it is clear that the analysis of tourist activities cannot be performed in isolation without taking into account the spatial interaction between di*ff*erent regions or their relationship with development in a given space. In this sense, it is not surprising that there is an increasing demand for studies which analyze the pattern of tourist activities in a space in order to obtain comprehensive information that can be taken into account for the proper management and planning of the activities at the destinations. This trend has materialized in the proliferation of a series of studies with this aim (Yang and Wong 2012, 2013; Majewska 2015, 2017; Li et al. 2015; Xing-Zhu and Qun 2014; Almeida-García et al. 2018; Chua et al. 2016; Polo Pena et al. 2015; Balaguer and Pernías 2013; Sánchez Martín et al. 2013; Rodríguez-Rangel and Sánchez-Rivero 2019, 2020; García-Palomares et al. 2015; Gutiérrez et al. 2016; Batista e Silva et al. 2018).

At the urban level, Yang and Wong (2012) studied the location of hotels through the construction of a LOGIT model that allowed them to determine that the first hotels to be located and those with the lowest service o*ff*erings have a greater predilection for occupying the most central locations in the city. In Hong Kong, Li et al. (2015) investigated the spatial association of urban tourism in relation to the type of land use, finding that commercial use has a strong association with the location of hotels. At the inter-regional level, Majewska (2015, 2017) focused on analyzing distribution patterns in Poland, observing the existence of di*ff*erent clusters and studying the determinants that lead to their formation.

By means of the analysis of spatial distribution patterns, groups of companies can be identified with similar behavior and, in turn, can be di*ff*erentiated from those that would be expected under a hypothesis of random distribution in the territory; locations can also be indicated in which tourist activities are highly concentrated and have implications which must be taken into account for proper management of the activities.

The importance, therefore, of the discovery and identification of these specific patterns in certain destinations underlies the implications that tourism discovery entails, ranging from infrastructure planning and transportation improvement, or the development of tourism products, to the satisfactory management of the social, environmental, and cultural impacts of tourism, correcting possible regional inequalities (Xing-Zhu and Qun 2014).

Among the techniques traditionally used to analyze tourist activities, the use of spatial association measures, both global and local, stands out. It should be noted that these present a great sensitivity, due among other factors to the demarcation of the boundaries of the territorial units (size, shape, position in the territorial division of the country, etc.), in addition to the neighborhood criteria used to define the spatial association (contiguity, Euclidean distance, the spatial weights matrix, etc.). Therefore, the decisions made to address the analysis regarding the criteria of neighborhood and territorial scale selected may a*ff*ect the results obtained (Majewska 2015, 2017; Rodríguez-Rangel and Sánchez-Rivero 2019, 2020; Sánchez-Martín et al. 2019).

In order to resolve the first of these questions, the use of a geostatistical perspective is proposed, i.e., the use as a basis of analysis of the Global Positioning System (GPS) coordinate of each of the entities studied (Majewska 2015, 2017; Yang and Wong 2013; Li et al. 2015; Xing-Zhu and Qun 2014; Almeida-García et al. 2018; Chua et al. 2016; Polo Pena et al. 2015; Balaguer and Pernías 2013; Sánchez

Martín et al. 2013; Rodríguez-Rangel and Sánchez-Rivero 2019; Sánchez-Martín et al. 2019). In order to overcome the second of the limitations, some authors have proposed the performance of di*ff*erent tests based on the characteristics of the territory under study so as to make a selection of the most appropriate distance criterion for it (Martín et al. 2018; Sánchez Martín et al. 2013; Rodríguez-Rangel and Sánchez-Rivero 2019, 2020). By carrying out di*ff*erent tests, the inherent limitation of this technique can be partly counteracted, but the results obtained remain dependent on the neighborhood criteria finally selected. Associations can be obtained which would not have been identified if they had chosen to define the neighborhood relationship according to another criterion. For this reason, the early studies carried out by Wall et al. (1985) suggest the joint use of di*ff*erent statistical techniques so as to give greater reliability and validity to the results obtained.

The region of Extremadura can be described as an emerging inland destination located in the southwest of Spain. It is characterized by having a rich heritage and landscape legacy that gives it enormous potential for the development of heritage and nature tourism; both typologies are highly dependent on generating sustainable development models around their main assets. Therefore, to properly plan tourist activities with an awareness of the needs of existing infrastructure by designing competitive products or managing possible economic, social or environmental imbalances that may exist in the territory, it is necessary to have exhaustive information on the spatial distribution of the activities at that destination.

Along these lines, there have been several studies that, by using di*ff*erent methodologies, focus on identifying and characterizing localized clusters. These studies have shown that the distribution of tourist activities in a space does not correspond to a random pattern but is found to be grouped into certain locations (Sánchez Martín et al. 2013, 2018; Rodríguez-Rangel and Sánchez-Rivero 2019, 2020; Sánchez-Martín et al. 2019; Sánchez-Rivero 2008). To date, however, to the authors' knowledge no alternative statistical technique has been used that allows, as Wall et al. (1985) suggest, confirmation that the results achieved are not influenced by the selected criteria compared with those obtained by complementary techniques pursuing the same purpose. Therefore, this paper aims to study the spatial distribution of accommodation in the region of Extremadura, Spain, using statistical techniques as an alternative to those previously used, spatial association measures, with the aim of assessing in the first place whether the activities are distributed following a random pattern. If this is not confirmed we aim to describe the structure that is identified in the intensity of the tourist activities.

In order to achieve its objectives, this paper is structured as follows: After this introduction a bibliographic review is carried out so as to determine the relationship between the tourist activities and the space. We then proceed to characterize the destination under study by synthesizing the results achieved with previous studies in the field. In the methodology section a description of the statistical techniques used to analyze the degree of intensity of the tourist activities in the space is given so as to enumerate the main results obtained in Section 5. Finally, the main conclusions and implications of the results of this research are collected.

2. The Importance of Space in Accommodation Distribution

In recent years there has been a tendency to recognize the importance of space in many economic processes (Goodchild et al. 2000), which is especially pronounced in the case of tourist activities because it analyzes the dimension. Geographical tourism can be useful to better understand the operation of this activity, while allowing knowledge to be derived for its management and marketing (Xing-Zhu and Qun 2014).

Tourist activities have a clear tendency to concentrate in a space, which is due, among other factors, to the preference of companies to be located around the main tourist attractions. As Carreras Verdaguer (1995) points out, this results in a high spatial concentration of both demand and tourism supply.

However, this tendency towards a strong concentration in a space cannot be explained by the existence of tourist attractions in isolation because sometimes the decision to locate in a certain territory can be justified by the existence of a strong business presence that acts as a focus of attraction per se.

Marshall (1920) emphasizes that companies can benefit from the existence of agglomeration economies in their location decisions. We understand by this that those economic externalities available to companies in large concentrations of economic activity arise because they allow a choice between a more specialized range of services. The author describes two main types of profit: production improvement and demand intensification.

The improvement of production is due to several reasons, such as the creation of a highly specialized labor market and the transfer of knowledge and technology, although as indicated in the work carried out by Canina et al. (2005), these types of benefits are more associated with technologically sophisticated industrial sectors rather than with service sectors with a low technological base. However, some studies carried out in the specific sector of tourism confirm how improvements in production are also likely to occur in this sector. This is the case of the work carried out by Polo Pena et al. (2015), in which it is confirmed that space agglomeration favors the spread of the adoption of a more market-oriented strategy among rural tourism companies that are spatially grouped.

For its part, the intensification of the demand that occurs as a result of grouping can be considered a source of the creation of magnetism towards the area while allowing companies to take advantage of better results than would be expected in an isolated location. As Majewska (2015) points out, the heterogeneity and density of the tourist o*ff*ering can also serve as a tourist attraction due to the diversity of services, such as transport and accommodation, infrastructure, and facilities for leisure activities, such as eating and drinking or participation in cultural, social, and sporting events. Therefore, an inadequate allocation of resources can sometimes be overcome if localization economies support the tourism industry (Yang and Fik 2014). As Capone and Boix (2008) point out, the growth rate of local tourism depends more on the strengthening of localization economies than on the natural resources that the destination possesses.

Given all of the above, companies can be expected to be aware of the benefits that come with their location in areas where they already have a strong business base that allows the creation of agglomeration economies in order to take advantage of positive externalities. At the same time, however, it should be borne in mind that as a strong business presence increases competition, it can also generate negative e*ff*ects on the performance of companies located together. Some authors identify an inverted U relationship between the number of existing hotels and the appearance of new hotels, which is explained by the fact that an intense level of competition distances new participants (Baum and Haveman 1997; Ingram and Inman 1996).

Along these lines, di*ff*erent studies have emerged which seek to examine in depth when the benefit is greater and who benefits most from the positive externalities created as a result of location in a cluster in which there is a strong business agglomeration. Chung and Kalnins (2001) conducted a study in Texas in 1992, the results of which show that agglomeration intensifies demand, particularly in rural markets in which the actions carried out by companies reduce the costs of seeking information. In addition, its results indicate that the location of small independent hotels near large hotel chains benefits the former by increasing their income as a result of the intensification of demand. Along the same lines, Canina et al. (2005) confirm that hotels of a lower category are more likely to receive positive spillovers when they are located in clusters with higher category hotels. On the other hand, the results of the study carried out by Freedman and Kosová (2012) reveal that the benefits of agglomeration vary according to hotels in di*ff*erent product segments, and that new hotels are more likely to choose an area with a greater concentration of hotels in other segments to seek greater product di*ff*erentiation. Balaguer and Pernías (2013) carried out a study in the region of Madrid in which they conclude that the spatial agglomeration of hotels significantly a*ff*ects both the price level and its dispersal and therefore the profitability of the business.

The results achieved by the various studies confirm that a joint location generates positive e*ff*ects; although they will not benefit equally all the members of the clusters formed, they will create positive externalities that will act as a force of attraction that hinders the homogeneous distribution of activities in a space. As Yang et al. (2014) point out, hotels are not randomly distributed in space; their locations

are normally grouped with other homogeneous or heterogeneous hotels to achieve an agglomeration e*ff*ect. In this context, the correct management of tourist activities requires thorough knowledge of the activity patterns created in the space for a double purpose: on the one hand to be able to enhance the positive e*ff*ects generated as a result of the joint location, and on the other hand to mitigate the possible adverse e*ff*ects arising from concentration of the activity in the space.

Knowledge of the pattern of distribution existing between accommodation establishments provides administrations with vital information for planning at both an urban and regional level, especially in those cases in which it is necessary to provide necessary infrastructure services or urban renewal (McNeill 2008).

On the other hand, this knowledge of the existing pattern also provides the possibility of improving possible regional inequalities and managing the social, environmental, and cultural impacts of tourism (Xing-Zhu and Qun 2014). In fact, although agglomeration o*ff*ers opportunities for obtaining advantages from positive externalities, as a result of high tourist intensity, negative consequences may also be generated for the destination, such as congestion, which prevents the creation of a model of sustainable tourism development. Lew and McKercher (2006) stress that the negative impacts of tourism tend to occur when a place is visited by more tourists than it can sustain.

As a result of all the above, the need to know how tourist activities are distributed in space for proper management is evident and this need has been materialized by the proliferation of a series of studies which aim to generate knowledge of this aspect.

One of the prevailing currents within the field of study is to track the routes generated by visitors to a specific destination. In this way a high degree of knowledge of how visitors behave at their destination can be achieved: what they visit, when they do so, and how long they remain at each of the di*ff*erent attractions. To obtain this knowledge, some of the work carried out is supported by GPS devices that allow the obtaining of very detailed information on the tourist flows of a destination. East et al. (2017) conduct a study on the visiting patterns of a specific attraction, with the result being that the majority of visitors follow similar routes by inertia, which means a greater likelihood of destination congestion. On the other hand, Galí Espelt and Antonio Donaire (2018) study the di*ff*erences in routes between those visitors who repeat visits at their destination compared with those who do so for the first time, with the result being that significant di*ff*erences are only obtained when they are experienced visitors, i.e., those who have visited the destination more than four times. Mckercher and Lau (2008) conducted a study which allowed them to synthesize the 78 movement patterns analyzed in 11 movement styles in Hong Kong.

The new sources of information of big data have also contributed to an analysis base for the performing of di*ff*erent studies aimed at obtaining information on the movement patterns of tourists, in addition to serving as a basis for analyzing the association of tourism and space. Chua et al. (2016) use information from the geotags of the Twitter social network to describe the flows of tourism in Cilento, with the result being that photos geo-tagged by tourists have a greater tendency to concentrate than those shared by residents of the area. The photos shared by the tourists themselves through di*ff*erent social media have also served as the basis for various studies that have contributed to generating information on the distribution of tourism demand at di*ff*erent destinations at a European level (García-Palomares et al. 2015; Gutiérrez et al. 2016; Batista e Silva et al. 2018).

However, if there is a field in which e*ff*orts have been focused on creating knowledge on tourist activities and their distribution in a space, there is no doubt that this is the distribution of the tourist o*ff*ering in the territory. To do this, some studies have focused on analyzing how accommodation companies are distributed in space, using the entity itself or the places o*ff*ered by each of the existing establishments as a reference base (Martín et al. 2018; Yang and Wong 2012, 2013; Majewska 2015, 2017; Li et al. 2015; Xing-Zhu and Qun 2014; Almeida-García et al. 2018; Balaguer and Pernías 2013; Sánchez Martín et al. 2013; Rodríguez-Rangel and Sánchez-Rivero 2019, 2020; Batista e Silva et al. 2018; Sánchez-Martín et al. 2019; Sánchez-Rivero 2008; Sarrión-Gavilán et al. 2015).

The ultimate purpose of these studies is to identify groupings of accommodation establishments in a space, i.e., the identification of spatial clusters. To do so they have used di*ff*erent techniques of spatial statistics, among which both global and local spatial association indicators stand out. To be specific, the Moran global statistic I together with the general G(d) of Getis and Ord and the LISA (Local Indicators of Association Spatial) maps stand out as the most commonly used indexes for the identification of spatial association or dependence (Moran 1948; Getis and Ord 1992; Ord and Getis 1995; Anselin 1995).

These techniques show great potential in the identification of spatial clusters, but it is necessary to define the spatial interaction between the di*ff*erent entities under study by establishing a neighborhood criterion that constitutes a weakness in the technique due to the dependence of the results on the criteria finally selected.

In the specific case of the territory on which the present study focuses, a series of studies have been carried out with a common purpose: ascertaining the pattern of distribution in the region. As a common result of all of these it was found that tourist activities are not distributed at random in the territory; there are areas in which there is greater tourist intensity (Martín et al. 2018; Sánchez Martín et al. 2013; Rodríguez-Rangel and Sánchez-Rivero 2019, 2020; Sánchez-Martín et al. 2019; Sánchez-Rivero 2008). To reach these conclusions, these studies used spatial association measures that allowed them to discover di*ff*erent clusters in which there is a greater tourist density. To date, however, to the authors' knowledge no study has been carried out to address the distribution in the territory with alternative statistical techniques that overcome the intrinsic limitations of spatial association measures, contrasting with greater reliability the results obtained as proposed by Wall et al. (1985).

This study therefore aims to confirm the spatial trend identified by previous studies by estimating an intensity function of the total accommodation of the region using non-parametric techniques: Ripley's $K(r)$ function, Gaussian kernel smoothing, and quadrant counting.

In order to help the reader understand better the results obtained in the next chapter, a description of the destination under study is given. This also facilitates a synthesis of the results achieved by the previous studies carried out there.

3. Case Study: Extremadura

Extremadura is a Spanish region located in the southwest of the Iberian Peninsula; its location can be seen in Figure 1. It consists of the two largest provinces in Spain, Caceres and Badajoz, and has a total surface area of 41,633 km^2. Its economy has traditionally shown a strong dependence on agricultural and forestry activities, and it is the Spanish region with the lowest GDP per capita (Instituto Nacional de Estadística 2019). In addition, it has a high unemployment rate, which reached 19.68% in the third quarter of 2019 (Instituto Nacional de Estadística 2002).

Figure 1. Location of area of study.

This unfavorable economic context has led the region to benefit from theLEADER (Liaisons entre Activités de Development de L´Economie Rural), LEADER II, and PRODER (Programa Operativo de Desarrollo y Diversificación de Zonas Rurales) European aid programs, which aim to diversify its economy in order to solve its demographic, social, and economic problems. Although these programs focus on developing di*ff*erent sectors, they have a special impact on tourism. In the specific case of the region under study, these grants have a*ff*ected the growth of the accommodation capacity of the region, especially in rural areas, which has greatly increased in recent decades (Sánchez Martín et al. 2013; Masot and Gascón 2008). To be precise, this sector has evolved from having 108 accommodation establishments with 1003 beds in 2001, to 9134 beds in 772rural accommodation establishments in 2018 (Instituto Nacional de Estadística 2020; Observatorio de Turismo de Extremadura 2019).

This has had a significant impact on the development of the accommodation pool in Extremadura, since from the total number of existing accommodation establishments (1575 for the year 2018) the relative importance of rural tourism for the sector as a whole can be appreciated as can be seen in Table 1.

Table 1. Tourism magnitudes of Extremadura (year 2018).

Type of Accommodation	Number Establishment	Number of Beds
Hotels	454	19.105
Non-hotels	349	12.910
Rurals	772	9.134
Total	1575	41.149

Source: Tourism Observatory of Extremadura (2019).

However, as noted by authors such as Sánchez Martín et al. (2013, 2018), this increase in the accommodation capacity of the region has not been equally distributed throughout the territory; it is more prevalent in certain territories that depend on their existing tourist assets. Neither has it been accompanied by a comparable growth in the number of travelers arriving in the region, which reached a total of 1,866,169 visitors who made 3,438,671 overnight stays in the region in 2018 (Observatorio de Turismo de Extremadura 2019). This fact has caused a series of imbalances that have been the reason for conducting various studies in order to understand how tourist activities are distributed in the region. Exhaustive knowledge of the distribution patterns of tourist activities will allow the design and planning of appropriate strategies for correct management of this activity by means of a sustainable development model that achieves the objectives pursued.

To the authors' knowledge the first study carried out to ascertain the pattern existing in the region is that of Sánchez-Rivero (2008). The author focuses on analyzing the distribution of tourist activities by considering both accommodation and restaurants. In addition, in analyzing the beds available, the division between hotel beds and rural accommodation is taken into account. The results of this research included the identification of three hotspots in the distribution of hotel beds in the main cities of the region: Badajoz, Caceres, and Mérida. In the case of rural accommodation, it identifies a series of clusters in the north of the region, to be precise in the territories of the Valle del Jerte and La Vera, and Tajo Internacional-Sierra de San Pedro, and in the vicinity of the National Park of the Monfragüe Biosphere Reserve. As far as restaurant locations are concerned, a random distribution pattern was found.

Martín et al. (2018), focused on analyzing the distribution pattern by comparing the positions o*ff*ered in the 2004–2014 period. Among the main results of the study they highlighted the identification of a cluster of high values in the north of the region, in the territories of La Vera, Valle de Ambroz, and Valle del Jerte, as well as in the main cities (Badajoz, Cáceres, and Mérida), albeit with di*ff*erent degrees of significance.

Rodríguez-Rangel and Sánchez-Rivero (2019) analyzed the distribution pattern of travelers arriving in the region, differentiating between those who choose to stay in hotel accommodation and those who prefer other types of accommodation. Their results reveal a preference for the three main cities in the region.

On the other hand, Sánchez-Martín et al. (2019) studied the distribution of rural accommodation in isolation, identifying areas of a strong concentration of beds in the region of La Vera, Zafra-Río Bodión, Vegas Altas, and in the Alange area. On the other hand, cold spots were identified in the vicinity of Montánchez, Sierra de Gata, and the Valle del Jerte.

Having their suspicions regarding the unequal distribution of beds and travelers, Rodríguez-Rangel and Sánchez-Rivero (2020) focused on analyzing, on the one hand the beds offered by the accommodation establishments, and on the other their level of occupation, using this as a proxy indicator of their level of efficiency. Their results confirm the largest grouping of tourist beds in the cities of Badajoz and Caceres, and helped to identify the presence of three clusters of high values (Badajoz, Caceres, and Mérida) and two of low values (Trujillo-Miajadas-Montánchez and the Villuercas-Ibores-Jara Geopark) with regard to the occupation level achieved.

In view of the results obtained some similarities can be appreciated but also certain discrepancies, which invite verification by means of statistical techniques as an alternative to those they used (measures of spatial association) to obtain their results.

4. Methodology

The data analyzed in this paper are spatial point patterns (SPP), which contain the XY (longitude–latitude) coordinates of the points. The hypothesis to be tested is the spatial homogeneity (or complete spatial randomness, CSR) of SPP. If it is rejected, the heterogeneous structure of intensity will be investigated. In territorial terms, "intensity" could be defined as the average density of spatial points, i.e., the expected number of points per unit area. In the case of CSR, we can speak of "uniform" or "homogeneous" intensity, whereas when the CSR hypothesis is rejected, we speak of "inhomogeneous" intensity.

If a point process **X** is homogeneous, for any sub-region B of the global region R the expected number of spatial points in B can be calculated as follows:

$$\mathrm{E}[\mathrm{N}(X \cap B)] = \lambda\, \mathrm{area}(B) \tag{1}$$

in which the constant of proportionality λ is the intensity. The empirical density of points, $\bar{\lambda}$, can be calculated as follows:

$$\bar{\lambda} = \frac{n(x)}{\mathrm{area}(R)} \tag{2}$$

with $n(x)$ being the total number of spatial points in the region R; and the area(R) being the total area of the region R. $\bar{\lambda}$ is an unbiased estimation of the true intensity λ.

The CSR implies the following:

1. The number of points falling in any region R has a Poisson distribution with a mean of λ.
2. The locations of the n points inside the region R are i.i.d. (independent and identically distributed) and uniformly distributed inside R.
3. The contents of two disjointed regions R_1 and R_2 are independent (Baddeley 2010).

To test the CSR hypothesis, the first step is to plot the point patterns observed in a rectangle $[\min(x), \max(x)] \times [\min(y), \max(y)]$ in which x and y represent the Cartesian coordinates of the points. To test the spatial homogeneity hypothesis in this rectangle, the Spatial Laplace Principle (Smith 2020) is applied. This principle states that if the square is divided into a large number (n) of grid cells and we consider a spatial point, each cell has the same probability ($1/n$) of containing the point. This principle induces in terms of probability a uniform probability distribution in the region. The assumption of

spatial randomness is that the locations of points in region R have no influence on one another. If C is a grid cell contained in R ($C \subset R$), a Bernoulli random variable $X(C)$ could be defined for each grid cell, in which $X(C) = 1$ if the point is located at C and $X(C) = 0$ otherwise. The spatial randomness implies that the random variables $X_i(C)$; $i = 1, 2, \ldots, n$ are assumed to be statistically independent for each grid cell C.

If the intensity of a point process varies from place to place (a nonhomogeneous process), the expected number of points falling in a small region of area du around a location u is calculated in the following way:

$$E[N(X \cap B)] = \int_B \lambda(u)d(u) \quad (3)$$

for all sub-regions B. In the above equation $\lambda(u)$ is called the "intensity function" of the process. This intensity function can be estimated by nonparametric techniques, such as quadrant counting, K-functions, and kernel smoothing (Baddeley 2010).

In quadrant counting the region R is divided into m excluding sub-regions ("quadrants") of equal areas $B_1, B_2, \ldots, B_m$. Then the number of points falling in each quadrant, $n_j = n(x\ B_j)$ for $j = 1, 2, \ldots, m$, is computed. A standard test for the null hypothesis of CSR is the χ^2 Pearson goodness-of-fit

$$\chi^2 \quad \frac{\sum_j (n_j - n/m)^2}{n/m} \quad (4)$$

in which $n = \sum_j n_j$, which is the total number of observed spatial points in region R. This Pearson goodness-of-fit test has a χ^2 distribution with $(m - 1)$ degrees of freedom.

An alternative to quadrant methods is the calculation of Ripley's $K(r)$ function to know whether the phenomenon of interest is randomly distributed throughout the study area. This function (Ripley 1977, 1988) is defined so that $\lambda K(r)$ equals the expected number of additional random points within a distance r of a typical random point of R. The estimation of the K function can be used to summarize aspects of inter-point "dependence" and "clustering". Taking into account that in the case of a completely random point process, $K(r) = \pi r^2$, deviations between the empirical y and theoretical K curves may suggest spatial clustering or spatial heterogeneity.

The K-function is given as:

$$K(r) = \frac{a \sum_{i=1}^{n} \sum_{j=1, j \neq i}^{n} k_{i,j}}{n(n-1)} \quad (5)$$

in which a is the area of the rectangle (window); n is the number of spatial points; and $k_{i,j}$ is a weight that will be equal to one when the distance between point i and point j is less than r and will be equal to zero otherwise.

It is possible to represent graphically not only the observed K function and the expected K function but also an interval estimation of exact expected values, including both a lower and a higher confidence envelope. This graph can be interpreted as follows:

- If the $K_{observed}$ function is larger than the $K_{expected}$ function for a particular distance r, then the distribution observed is more clustered than a random distribution.
- If the $K_{observed}$ function is smaller than the $K_{expected}$ function for a particular distance r, then the distribution observed is more dispersed than a random distribution.
- If the $K_{observed}$ function is larger than the higher confidence envelope function ($K_{HiConfEnv}$) for a particular r, then the spatial clustering for that distance is statistically significant.
- If the $K_{observed}$ function is smaller than the lower confidence envelope function ($K_{LoConfEnv}$) for a particular r, then the spatial dispersion for that distance is statistically significant.
- If the $K_{observed}$ function is similar to the $K_{expected}$ function for a specific distance r, then the distribution observed is a random distribution.

Finally, in order to identify possible XY coordinates where the hypothesis has been disproved another graphical approach is possible. Thus, a Gaussian kernel density estimation (Diggle 1985) can be plotted to obtain an impression of local spatial variations in intensity.

The kernel estimator of $\lambda(u)$ is:

$$\hat{\lambda}(u) = e(u) \sum_{i=1}^{n} k(u - x_i) \quad (6)$$

in which $k(u)$ is the kernel (an arbitrary probability density) and $e(u)^{-1} = \int_R k(u - v)dv$ is an edge e*ff*ect bias correction (Baddeley 2010).

A kernel density with a unique color (the same number of points in each grid cell) means a CSR scenario, while di*ff*erent colors (a di*ff*erent number of points in each grid cell, i.e., a di*ff*erent intensity) mean a clustered or dispersed scenario. In addition, this kernel estimation can also be represented in perspective plots of a surface over the x–y plane and in a contour plot.

5. Results

The SPP analyzed represents the whole population of accommodation establishments located in Extremadura on 1st January 2019 (1591 spatial points). This population includes both hotel establishments and nonhotel establishments (rural accommodation, tourist apartments, campsites, and hostels). All graphs and calculation presented in this epigraph were produced using the R package spatstat (Baddeley and Turner 2005).

The spatial representation of these establishments is shown in Figure 2. The Coordinate Reference System used in this research is EPSG:4326—WGD84. In Figure 2, the X-axis (longitude) includes values (in decimal degrees) between −7.55° and −4.75°, while the Y-axis (latitude) includes values between 37.9° and 40.5°. These limits define the minimum and maximum geographical coordinates of Extremadura, so that all the spatial points analyzed are included in the window represented by Figure 1 (no space points are excluded).

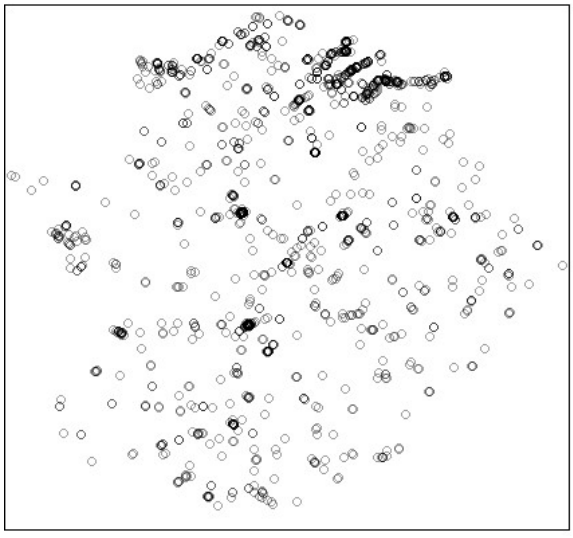
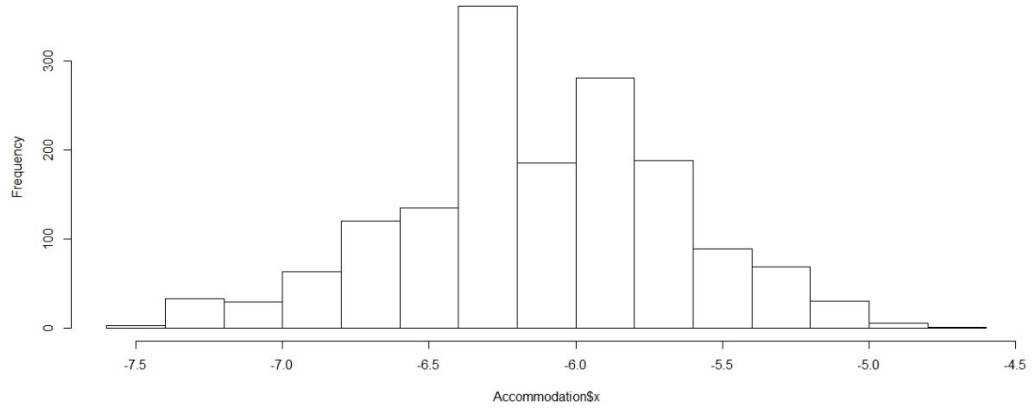


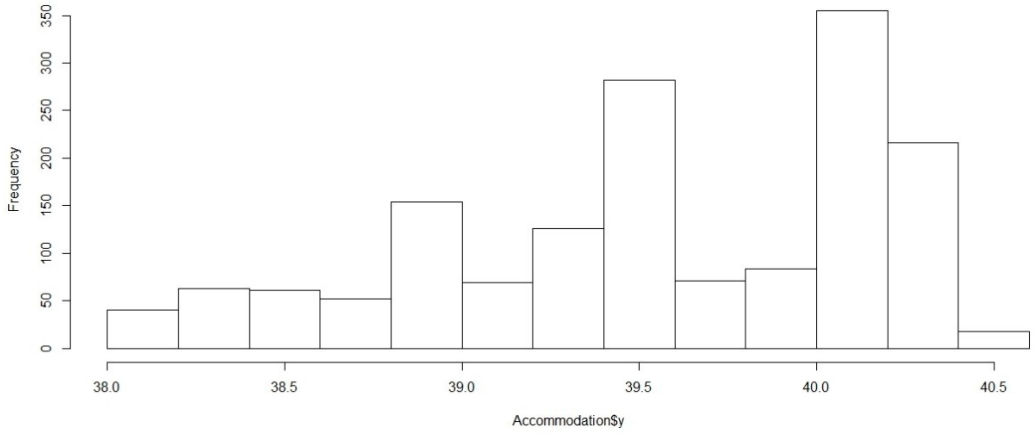
Figure 2. Spatial representation of accommodation establishments in Extremadura.

As can be seen, the spatial distribution of the accommodation establishments appears not to be uniform throughout the regional territory. Indeed, it is intuited that the northern third of the region concentrates a higher number of establishments than the remainder of the region. If XY coordinates are represented in the form of histograms (see Figure 3), the lack of homogeneity of distribution of the location of accommodation establishments in Extremadura can be graphically observed. A higher

frequency of establishments can thus be identified in the central longitude strip (mainly between −6.4° and −6.2° and also to a lesser extent between −6.0° and −5.8°) and the northern latitude strip (between 40.0° and 40.2° and between 39.4° and 39.6°).



(**a**)



(**b**)

Figure 3. Histograms of the XY coordinates of accommodation establishments in Extremadura. (a) Histograms of X coordinates of accommodation establishments in Extremadura. (**b**) Histograms of Y coordinates of accommodation establishments in Extremadura.

To confirm statistically this graphically perceived heterogeneous structure of intensity in the distribution of establishments, a Ripley's K(r) function was estimated (see Figure 4). As can be seen, there are significant di*ff*erences between the Ripley's function observed and the Ripley's function expected given above the CSR hypothesis. For all r values it can be concluded that the observed distribution of establishments in the region is more concentrated than random distribution, because in all cases the function observed is higher than the functions expected.

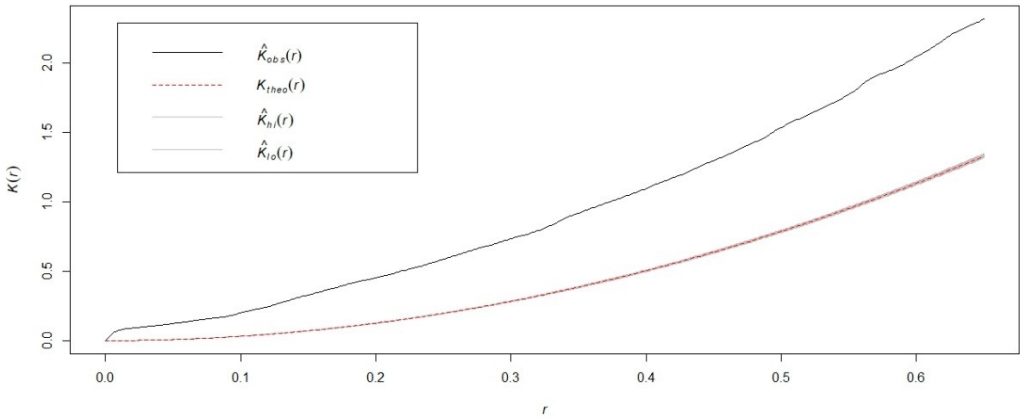
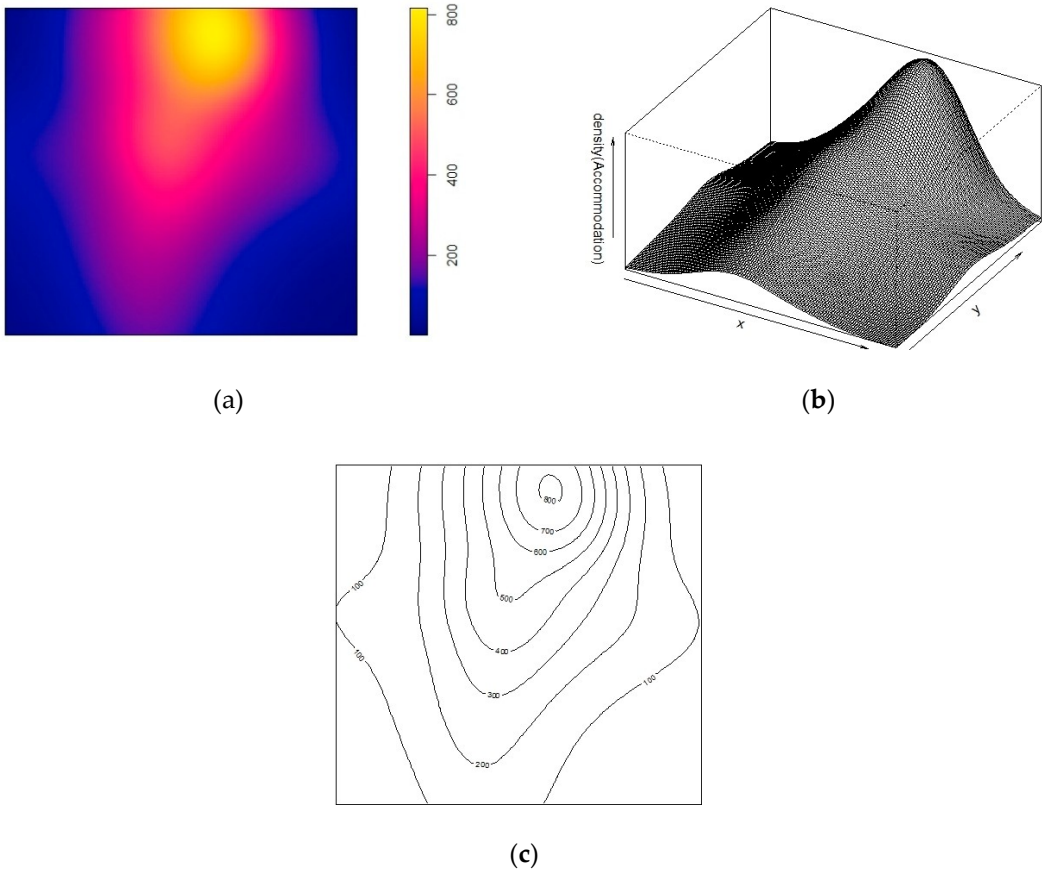


Figure 4. Ripley's $K(r)$ function of accommodation establishments in Extremadura.

Another way to confirm this nonhomogeneous intensity is to estimate a Gaussian kernel function (see Figure 5).



(a) (**b**)

(**c**)

Figure 5. Kernel density estimation of the intensity of accommodation establishments. (**a**) Adaptative intensity (**b**) Perspective plot. (**c**) Contour plot.

The previous kernel estimation shows where the intensity of accommodation establishments reaches its maximum and minimum values. Thus, it is intuitive to verify a clear pattern of a higher intensity in the central longitude strip, but with a nonhomogeneous intensity inside (because this intensity clearly decreases from north—the highest accumulation of establishments of the region—to south—the lowest accumulation).

Finally, a quadrant counting approach was used to confirm the previous results. A 4 × 4 quadrant was considered and the observed number of accommodation establishments in each grid cell was calculated (Figure 6). The expected number of spatial points per quadrant in the case of the CSR hypothesis is in this case equal to 99.4. It is easily verifiable that there are important di*ff*erences between the SPP expected and observed in every grid cell.

11	180	431	28
58	226	149	69
32	149	76	34
14	102	32	0

Figure 6. 4 × 4 quadrant counting of accommodation establishments in Extremadura.

In addition to Figure 6, Figure 7 shows not only the number of spatial points observed (top left), but also the number expected (top right) and the Pearson residual calculated by dividing the di*ff*erence between the value observed and the value expected by the square root of the value expected (bottom). The higher the absolute value of the Pearson residual, the clearer the breach of the CSR hypothesis.

11 99.4 -8.9	180 99.4 8.1	431 99.4 33	28 99.4 -7.2
58 99.4 -4.2	226 99.4 13	149 99.4 5	69 99.4 -3.1
32 99.4 -6.8	149 99.4 5	76 99.4 -2.4	34 99.4 -6.6
14 99.4 -8.6	102 99.4 0.26	32 99.4 -6.8	0 99.4 -10

Figure 7. Values observer, values expected and Pearson residual in a 4 × 4 quadrant counting of accommodation establishment in Extremadura.

The figure above allows the identification of the territories where a higher intensity of accommodation establishments can be found. These territories are, on the one hand the third quadrant (row 1, column 3; delimited geographically between [39.9°; 40.5°] longitude and [−6.15°; −5.45°] latitude), and on the other hand the sixth quadrant (row 2, column 2; delimited between [39.2°; 39.9°] longitude and [−6.85°; −6.15°] latitude) (see Figure 8).

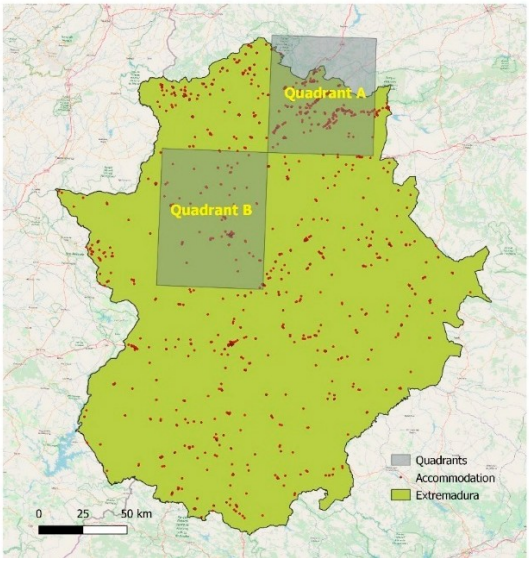


Figure 8. Identification of a higher intensity of accommodation establishments in Extremadura.

Finally, a chi-squared test of CSR using the previous quadrant counting was carried out. The value of this test was 1850.9 with 15 degrees of freedom and an associated bilateral *p*-value equal to 0.0000. The hypothesis of complete spatial randomness for the distribution of accommodation establishments in Extremadura thus has to be clearly rejected at a 5% level of significance. It can be concluded that there is a heterogeneous spatial distribution of the accommodation establishments in Extremadura.

6. Discussions

The verification of the CSR hypothesis is crucial in the management and planning of tourist destinations. If the intensity of accommodation establishments is uniform in a destination, it could be assumed that the advantages and disadvantages of tourist activities will be manifested with the same intensity in each place in it. However, if this intensity is not uniform, the concentration of the tourist o*ff*ering may be directly related to a higher intensity of tourist activities. Consequently, the tourist management/planning and strategic development policies of the destination should not be applied in the same way. Merely as an illustration, therefore, the consequences of a heterogeneous intensity in a tourist destination could be as follows:

a. Investment in tourism infrastructure, both public and private, should be mainly directed at certain territorial spaces and not at all equally. Complementary tourist infrastructure (catering, service companies, travel agencies, etc.) should therefore be created in the destination areas where the accommodation intensity is highest.
b. Tourist pressure is not the same throughout the destination. In some spatial locations the pressure of the activity on the territory is reduced (a low intensity of accommodation); in other locations the tourist pressure can be very high (a high intensity of accommodation) especially in the high season. Consequently, the tourist sustainability of the territory is not equally achievable throughout the destination.
c. Tourist accommodation establishments do not compete with each other in the same way to attract customers depending on the intensity of accommodation at the destination. In the case of accommodation establishments located in geographical spaces of low or very low intensity, the mutual competence of which is very limited or zero (as they operate under the system of oligopoly and even monopoly in some cases), the accommodation located in spaces with a high or very high intensity (perfect competition) will be forced to compete with each other to attract customers. This generates better products and services at market prices with the consequent benefits for the customer.

d. The creation of packages and tourism products is also conditioned by the number of accommodation companies operating in the territory. In a geographical space where there is a high concentration of accommodation there will also be a high intensity of other tourist companies (restaurants, tour guides, complementary activity companies, etc.). The development of these packages will therefore be easier in locations of the destination where there is a high intensity of tourist activities than in those where there is a low intensity.

For the above reasons it is important to identify the geographic spaces within a territory that have higher expectations of tourism development, as they will be those in which the highest levels of accommodation intensity are located.

In the case which concerns us, the analysis will focus on the two quadrants in which the accommodation intensity is much higher than expected in the case of complete spatial randomness (CSR). These two quadrants (Figure 6), delimited between the 39.9° and 40.5° longitude coordinates and −6.15° and −5.45° of latitude (Quadrant A), and between the 39.2° and 39.9° longitude coordinates and −6.85° and −6.15° of latitude (Quadrant B), are analyzed below to quantify the advantages or disadvantages in terms of tourist activities.

Quadrant A includes three traditional micro-destinations in Extremadura linked to cultural tourism (Plasencia), nature tourism (Valle del Jerte and La Vera), and active tourism and spas (Valle del Ambroz). The tourist magnitudes of these three micro-destinations are presented in Table 2 from the perspective of both supply and demand. As can be seen, the number of beds in the quadrant amounts to 13,256, which are mainly concentrated in the Valle del Jerte and La Vera. The average size of the accommodation establishments ranges between 30.8 places per establishment in the Valle del Ambroz, and 43.2 places per establishment in the municipality of Plasencia. The annual occupancy rate of these establishments is well above the regional average (36.24% for hotels and 18.13% for rural accommodation in 2018 according to data from the Spanish National Statistics Institute), since the occupancy rate of both the Valle del Ambroz and the municipality of Plasencia is around 46%, while that of the Valle del Jerte and La Vera (with a clear predominance of rural accommodation rather than hotels) is 31.36%. The number of visitors in these three micro-destinations during 2018 was almost 348,000 tourists, 18.70% of the total number of visitors to the region. Finally, the overnight stays of these three micro-destinations in 2018 were 833,000, which means that a quarter of the total overnight stays registered in the region were located at quadrant A.

Table 2. Tourism magnitudes of micro-destinations included in Quadrant A (year 2018).

Tourism Magnitudes	Valle del Ambroz	Valle del Jerte and La Vera	Municipality of Plasencia
Number of establishments	125	242	35
Number of beds	3846	7898	1512
Ratio beds/establishment	30.8	32.6	43.2
Occupancy rate	46.97%	31.36%	46.46%
Total number of visitors	100,254	147,644	100,090
% of visitors in the region	5.4%	7.9%	5.4%
Total number of overnight stays	290,155	368,348	174,633
% of overnight stays in the region	8.4%	10.7%	5.1%

Source: Tourism Observatory of Extremadura (2019).

With these figures it is clear that tourism sustainability policies must be applied basically in these three micro-destinations, and especially in the Valle del Jerte and La Vera, in which the state of preservation of its natural environment is its main tourist asset. On the other hand, the combination of di*ff*erent tourism types (cultural, nature, active, thermal, etc.) in a very small geographical space facilitates the designing of combined tourist packages to increase the average stay in the area. Finally, the accommodation companies in the area are the most competitive in the region, since their high

number forces them to o*ff*er tourist products and services of excellent quality at a competitive price due to the numerous options available to tourists in this area.

Quadrant B includes the two most representative icons of tourism in Extremadura: the city of Caceres, which in 1986 was declared a World Cultural Heritage Site; and Monfragüe National Park, the regional treasure for nature tourism which was declared a UNESCO Biosphere Reserve in 2003. The most significant tourist figures of 2018 in this Quadrant B are shown in Table 3. As can be seen, the total number of beds available in these two iconic micro-destinations rises to 5720, with the average size of the establishments being smaller than those of Quadrant A: 24.8 beds per establishment in Caceres and 27.5 beds per establishment in Monfragüe. The average annual occupancy rates of these establishments reach almost 50% in Caceres and 27.3% in Monfragüe; in the latter territory almost the entire o*ff*er of accommodation is of a nonhotel nature (rural hotels and rural lodging). The number of tourists who visited the micro-destinations of this Quadrant B during 2018 reached a total of 412,565 visitors, a figure representing 22.1% of the total visitors to the entire region. Finally, the overnight stays generated by these visitors amounted to almost 700,000, which is 20.2% of the total volume of overnight stays in the region analyzed.

Table 3. Tourism magnitudes of micro-destinations included in Quadrant B (year 2018).

Tourism Magnitudes	Municipality of Caceres	Monfragüe National Park
Number of establishments	145	77
Number of beds	3601	2119
Ratio beds/establishment	24.8	27.5
Occupancy rate	49.55%	27.30%
Total number of visitors	341,524	71,041
% of visitors in the region	18.3%	3.8%
Total number of overnight stays	554,650	141,736
% of overnight stays in the region	16.1%	4.1%

Source: Tourism Observatory of Extremadura (2019).

The exceptional nature of the fact that two major tourist attractions are concentrated in Quadrant B and must be subject to special protection (a city declared a World Heritage Site and a national park declared a Biosphere Reserve less than 40 kilometers apart) obliges the tourism authorities in the region to be especially vigilant to ensure the sustainable tourism development of the area. In this sense it is necessary to carry out analyses on the concentration of travelers throughout the year, to determine the carrying capacity of the territory, and to establish restrictions on the carrying out of certain tourist activities if they may harm the protected cultural and natural heritage.

On the other hand, for private investment initiatives in the tourism sector this tourist attraction pole of Cáceres–Monfragüe represents an excellent opportunity to establish new tourism businesses as the interrelation with other tourism products and services (restaurants, active tourism enterprises, etc.) facilitates the success of these businesses if they can take advantage of scale economies and synergies between companies in the tourism sector of the quadrant.

Finally, by way of conclusion, the following comments can be made.

The spatial intensity of the accommodation establishments in a certain territory determines the possible existence of territorial specialization focusing on tourism. For this reason, the verification of the hypothesis of complete spatial randomness in the geolocation of accommodation establishments is a necessary analysis for any tourist destination.

If heterogeneity of the spatial intensity of the accommodation establishments is confirmed, it is necessary to locate the areas of the territory where the intensity is greater, since public and private tourism management policies must be oriented mainly towards those specific areas of the territory in which tourism specialization processes have been detected.

Sustainability processes, competitiveness strategies, and scale economies in the tourism sector have a clear spatial component. Not all tourist destinations or micro-destinations are equally sustainable,

since the tourist pressure (which was measured by the intensity of accommodation establishments) is not the same in all of them. On the other hand, the high intensity of accommodation determines a competitive situation of close to perfect competition, in which market bidders cannot act on prices, which forces them to offer higher quality (more competitive) tourism products and services to stay in the tourist market. Finally, the business success of tourist accommodation in a space where there are no other tourist offerings (other accommodation, restaurants, tourist guides, complementary activities, enterprises, etc.) is much more difficult if the offer of accommodation (and other complementary services) is very high. Therefore, the high intensity of accommodation establishments favors the emergence of synergies and scale economies in the tourist destination.

7. Conclusions

Due to the major implications that the identification of groups with a high degree of tourist intensity represents for the satisfactory management of this activity, this study started with the objective of being able to contrast through statistical techniques an alternative to those traditionally used in the distribution of the tourist activities in the region of Extremadura.

The results obtained partly confirm those previously found by similar research. The identification of two high intensity areas in Quadrant A, the Valle del Jerte, the Valle del Ambroz, and La Vera, is a common conclusion reached by most previous studies, especially those focusing on identifying rural accommodation (Sánchez Martín et al. 2013; Sánchez-Rivero 2008). The same is true of the identification of the accommodation potential existing in Quadrant B, which has also been verified by the results obtained by previous research. However, it is striking that a common result among them, i.e., the identification of a high degree of concentration of the squares between the three main cities, is not confirmed by this study. This difference may be due to the difference in the average number of beds offered by different types of accommodation, hotels and others. For this reason, and in order to confirm the results achieved and to continue gaining knowledge of the spatial distribution of tourist activities, it would be interesting to be able to replicate this study taking as a reference the beds offered by each of the accommodation establishments in the region.

Regarding the implications of the results achieved, it should be noted that it would be important for destinations that are inserted in each of the quadrants identified with a strong intensity of tourist activity to carry out a detailed analysis of their carrying capacity. One of the priority objectives that the development of tourist activity in a destination must pursue is that it be carried out under sustainable criteria, especially taking into account that the identified areas are characterized by being natural resources, as is the case of the Ambroz Valley, Valle del Jerte and la Vera, or Monfragüe Natural Park. Therefore, before establishing the development strategy for these micro-destinations, managers should know whether or not the maximum load capacity of the destination has been reached, in order to establish lines of action in order to achieve sustainable management.

Similarly, once the areas in which tourist activity is most intense have been identified, it would be of great value to inquire about the determinants of its further development in order to achieve more balanced development in the region as a whole. Carrying out a benchmarking strategy in the identified micro-destinations can help, especially since it is an emerging destination, to know what has been the reason for their greatest success and to design growth strategies that can connect with the target audience allowing further development of the sector.

Finally, the findings achieved should also serve as a guide for destination managers in order to determine, based on the level of activity achieved, which are the priority areas for making investments in infrastructure, based on the objectives pursued by the competent administration.

On the other hand, the results obtained in this research are difficult to compare with those obtained by previous research regarding other destinations, since, as far as the authors are aware, an analysis of the existing pattern in a destination similar to that of the destination has not been performed. The selected destination is characterized, as already indicated, as being an inland destination that is in the growth phase of its tourist activity. However, there are characteristics that could be expected to be

comparable, thus previous studies tend to identify island and coastal areas as locations of greater tourist intensity, as well as higher-hierarchy cities (Majewska 2015; Yang and Wong 2013; Sarrión-Gavilán et al. 2015). Considering the characteristics of the destination, it would be expected that the main cities of the region, namely its capital (Mérida) and the provincial capitals, Badajoz and Cáceres, stood out for being among the locations with the highest tourist intensity. However, this characteristic is only presented in the city of Cáceres, therefore, it would be interesting to investigate why this is happening in the study to determine if the interior destinations do not meet this pattern, or if, on the contrary, it is a distinctive feature of the selected destination.

Di*ff*erent lines of research may be suggested aimed at alleviating some of the weaknesses and questions that arise as a result of the outputs of this study. Firstly, it would be interesting if the distribution pattern analysis could be carried out in destinations comparable to the one selected for this research, that is, emerging destinations in the interior, in order to verify whether the results achieved could be generalizable to this type of destination. Secondly, it would be valuable to be able to disaggregate the analysis by type of establishment since the di*ff*erent capacity and characteristics of each of the accommodation types could provide information that would substantially enrich the results achieved. Finally, it would be very helpful to be able to study the evolution of the identified pattern over time in order to obtain more information about how the distribution pattern of the activity behaves as the destination reaches its maturity phase.

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CAPÍTULO 4

SPATIAL INTENSITY IN TOURISM ACCOMMODATION: MODELLING DIFFERENCES IN TRENDS FOR SEVERAL TYPES THROUGH POISSON MODELS

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Article

Spatial Intensity in Tourism Accommodation: Modelling Differences in Trends for Several Types Through Poisson Models

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Abstract: The distribution pattern of tourist activity in space represents valuable information to improve the management of a tourist destination. This is why there is a trend in the current literature in proposing modelling that allows for the incorporation of how tourist activity is distributed in an operational way in order to characterize and measure the patterns identified for tourism management. The present study focuses on carrying out this modelling in an inland territory in an expansion phase which, according to the knowledge available from previous work, presents a strong territorial imbalance in the distribution of its housing pool, the region of Extremadura in Spain. For this reason, tourism intensity is modelled through a Poisson process to determine which model best fits the pattern of accommodation in the region. The results represent a valuable tool for public–private management of the tourism sector in the area under study.

Keywords: spatial point pattern (SPP); modelling trends; tourist intensity; Poisson's models; Extremadura; tourism management

1. Introduction

The use of spatial statistic techniques to obtain improved knowledge of tourism activities is nowadays an increasingly common practice. It is evident that tourism is a geographical phenomenon, which means that considering the spatial interaction between space and tourism activity in the analyses carried out is a crucial practice for the proper planning and management of tourism activities.

Knowledge of the localization patterns of tourism supply and demand provides vital information for destination managers, investors, and the remainder of the private sector. Knowing the location of the accommodation therefore provides essential information for regional planning efforts, especially in those cases involving the planning of infrastructure services [1]. For their part, private investors obtain valuable information on market access for potential tourists from knowledge of the location pattern of hotel accommodation, and also use it to understand the level of competition existing in a given territory [2].

For this reason, a series of studies are emerging from the academic field that seek to elucidate knowledge about the distribution patterns that tourist variables follow in space. In this way, work that aims to analyze the patterns of tourist activity in the territory has proliferated in recent years [3– 17].

To achieve their objectives, most of these works have used spatial association measures such as Moran's I or Getis and Ord's G [18,19], managing to identify different regimes of spatial association in each of the territories analyzed. Although these indices have demonstrated their validity to analyze

associations in space, they present a series of limitations in their use, among which a great sensitivity to certain parameters, such as the neighborhood criterion used (euclidean distance, contiguity, spatial weight matrix, etc.), or the influence of the demarcation of the administrative limits of each territory (size, shape, position in the territorial division, etc.). For all these reasons, Wall et al. (1985) [20] recommend using various statistical techniques to obtain greater reliability and validity in the results. On the other hand, the objective pursued by this work is not so much oriented towards identifying spatial trends in the distribution of tourist accommodation in the region, but rather the modeling of this trend in order to offer information on the spatial trends of the data to destination managers that can be of help in decision-making on the most appropriate policies for tourism development in the region. The information offered by this modelling could be used for the proper planning of tourist activity in the region, helping, for example, when making decisions about the suitability of making infrastructure investments in a certain location. Therefore, the objective is to propose the model that best describes how tourist accommodation is being distributed within the region under study.

Along these same lines, and in order to be able to synthesize the information obtained in an operational way after analyzing the interaction of tourism and space, different models have also been proposed, both theoretical and empirical, which aim to help to characterize, map, and measure the identified spatial structures in order to help decision-making in tourism. Yang et al. [2] carried out a review of the main models proposed in the current literature, concluding on one hand that there is no superior method in all situations; for this reason, adapting the method to the characteristics of the territory to study is a great help. On the other hand, as a result of their work, it is confirmed that most previous research takes the intra-metropolis area as a spatial reference, but there is a shortage of studies providing information on how tourism activities are distributed on an intra-regional scale, despite the usefulness of this information for the strategic planning of the destination [21–24]. To be precise, of the 54 papers reviewed to carry out their study the authors found that only 12 used the intra-regional scale (within the territorial limits of a whole region) as a reference for their analysis.

Taking into account all that has been said so far, the main objective of this research is to generate knowledge about this gap in the current literature. To do so, we intend to propose an empirical model that shows a satisfactory level of adjustment in the pattern existing in the distribution of accommodation in the region of Extremadura in Spain. It is therefore an analysis on an intra-regional scale which also takes an inland region as a basis for its analysis that is in a stage of expansion.

In order to achieve this objective, in this study, the tourist intensity is modelled through a Poisson process which, once a non-homogeneous distribution of the activity is verified, allows the definition of conditioned tourist intensity based on the location of the pattern of points that represent all the accommodation establishments existing in the region and therefore the mention of the existence of a spatial trend. In order to create this analysis, the three main types of accommodation existing in the region are considered (hotel, non-hotel and rural) so as to confirm whether there are significant differences that must be considered in the distribution of each type of accommodation. After verifying the non-homogeneous distribution of the accommodation in the space, different models are initially proposed that are estimated using a maximum pseudo-likelihood method for Poisson models to subsequently validate whether these models fit the data well and ensure that all their terms are appropriate. Finally, the different models proposed are compared to check which best fits the pattern of points observed in the region.

The classification carried out to distinguish between the three typologies considered in the present investigation (hotel, non-hotel and rural) follows the criteria established by the legislation in force in the region under study. Specifically, it can be seen in Law 2/2011, of 31 January, on Tourism Development and Modernization. In this law, a clear classification is established, of which establishments are included within each of the typologies and can be summarized as follows: hoteliers (hotels, hotel-apartments, hostels and pensions), non-hoteliers (tourist apartments, tourist hostels, camps, camping areas, motorhome areas) and rural (rural houses and hotels).

The main contributions that are pursued with the completion of this work can be summarized as follows. On one hand, the knowledge extracted from this work will allow us to

propose a modelling adjusted to a destination which, owing to its peculiar characteristics as an interior destination in a growth phase, does not have a background in current literature to the best of the authors' knowledge. On the other hand, although tourism intensity and spatial distribution patterns have been analyzed by different studies in the target area of study, to date, analyses have not taken into account a disaggregation of the existing accommodation establishments in the main categories in the region: hotel, non-hotel, and rural accommodation, which is the perspective used to carry out the analysis of this research. Therefore, the results achieved from the latter will be a valuable tool for the public–private management of tourism activities in the region.

The following research is structured as follows to achieve our goals. After this introduction, Section 2 is a bibliographic review of the main contributions made in this field. The area under study is subsequently described exhaustively so that the reader can contextualize the situation of the tourism sector in the region. Section 4 describes the methodology to be used for the development of this research work. Finally, Sections 5 and 6 list the results of the analysis and their main conclusions and implications for tourist activity in the region.

2. The Importance of Space in Accommodation Distribution

Correct planning in the tourism industry involves having exhaustive information, and for this reason, it is important for this sector to have techniques that allow for the monitoring and analysis of tourist flows. This allows us to obtain exhaustive information for correct decision-making [25]. In addition, tourism variables have a strong interaction with the territory which is characterized by an unequal distribution within and between the territories [17]. For all these reasons, knowing how tourist variables are distributed in space is essential for the correct management of tourist activity.

In effect, analyzing the geographical dimension of tourist flows helps us to understand the characteristics of their distribution and transition, while it is a valuable input for tourism management and marketing. For this reason, the variable space has been recognized and taken into account in more and more economic processes [26].

This trend is especially accentuated in the case of tourism, since this sector is highly dependent on the tourist assets and attractions that are found in specific locations, which results in a high spatial concentration in terms of both supply and demand [27]. The tourist concentration of companies must, however, be understood not only as a spontaneous process motivated by the nature of the business involved, but also as a mechanism of positive response between the demand and the productive system of tourism, which tends to develop the so-called economies of agglomeration [28].

The agglomeration economy is understood to be the geographical concentration of interconnected companies, related industry companies, and associated institutions in related fields which cooperate but also compete [29].

The basic premise of agglomeration is that the spatial grouping of interrelated industries or entities can be beneficial to the economy as a whole, as well as to sectors and companies grouped in a certain location [30]. Marshall [31] points out that companies can benefit from those economic externalities, which are also called geographic spillover effects, that occur in those companies that choose to locate areas where there is a strong concentration of economic activity, with the purpose of intensifying the offer of a range of more specialized services.

The main benefits deriving from the formation of agglomeration economies can be summarized as follows. Firstly, transaction costs fall while the exploitation of scale economies increases through the expansion of risk and the improvement of access to complementary resources [32]. Secondly, the growth of long-term stakeholder conflict resolution costs is avoided [33]. Finally, the coordination of related policies and actions is improved to promote the consideration of the economic, environmental and social impacts of tourism [34]. In short, it can be synthesized that there are two different types of profit: improvement in production and intensification of demand [31].

From the first studies carried out by Marshall [31], Hoover [35] and Jacobs [36], which were more focused on the manufacturing industry, a series of studies have emerged to analyze the effects of agglomeration economies in the service sector [37–40] which have particular influence on the specific field of tourism.

Some authors even consider agglomeration to be the key factor for the promotion of the development of tourism through externalities, which encourage competition and cooperation between companies [41,42]. This ensures that the growth ratio is more related to betting on localization economies than with the endowment of natural resources that destinations have [43], so that destinations can overcome an inadequate resource base if the localization economies support the tourism industry [44].

For all these reasons, there is a belief that agglomeration economies have become an important driving force in the development of tourism [45,46]. For this reason, numerous studies have examined how agglomeration theories and geographic spillover effects affect the spatial pattern followed by tourist accommodation in a given territory.

Most of the studies carried out are exploratory in nature and therefore seek to identify spatial trends through the use of spatial statistical techniques that can help with the correct management and planning of tourist activity in the territories that have been targeted. From the initial studies of Wall et al. [20], the amount of research pursuing this purpose as well as diversifying the techniques used for this purpose has intensified. Therefore, without wishing to be exhaustive, the work of Majewska [3,4] and of Majewska and Trukolaski [47] focusing on the analysis of the pattern of tourist activity in Poland and other countries in central Europe could be highlighted, identifying different clusters that represent important outputs for tourism management in these territories.

For their part, Yang and Wong [5] identify the presence of a cluster in China which they associate with certain coastal areas, mountainous regions, and cities acting as gateways or higher hierarchies, which in addition produce a spillover effect that extends beyond natural boundaries.

García-Palomares et al. [15], for their part, use big data techniques which allow them to identify certain hotspots through the movement of tourists in eight of the main European cities; they conclude that Rome is the city with the strongest spatial concentration compared with the other destinations analyzed. Together with previous studies, other analyses pursuing the same activity could be highlighted in a descriptive manner so as be able to identify and describe the spatial pattern of tourist activity in specific territories [10,16,17,44,48–53].

Parallel to these studies—the results of which have helped to confirm that the distribution of tourism variables in space is not homogeneous but rather shows a tendency to concentrate in space, causing synergies and contagion effects—others have been developed to demonstrate the effects of this concentration of supply in space.

A large proportion of these studies have focused on contrasting the agglomeration effect in the intensification of demand. Chung and Kalmins [54] carried out a study in Texas in 1992 on a sample of hotels and motels to determine which type of company contributes the most to creating externalities and which type benefits the most from them. Among their main conclusions, they found that the presence of chains intensifies the demand, especially in rural markets, with independent hotels obtaining benefits from being located near these chains. For their part, Canina et al. [22] carried out research in the USA on a sample of 14,955 companies to confirm the benefits and disadvantages of the competitive group, they detect that the hotels of higher category are those that generate those positive effects from which those hotels of a lower category located next to them benefit. Finally, Freedman and Kosová [55] conclude that the benefits of the agglomeration depend on the type of hotel, and that the chosen location depends on the degree of concentration and diversity that the complex reaches, preferring those areas in which its product segment is not present.

As a conclusion of all the above, it is confirmed that the concentration of accommodation in a certain area helps to intensify demand and that it is important for this spatial concentration to have a supply diversified enough to generate high profits in order to reduce the possible adverse effects of excess competition. As Majewska [3] affirms, the heterogeneity and density of the tourist supply can also serve as a tourist attraction.

As far as the improvement of production is concerned, although Canina et al. [22] mention these types of benefits such as the creation of a highly specialized labor market, the transfer of knowledge or technology, among others, they are usually more associated with technologically sophisticated industrial sectors. A series of studies have been carried out that have helped to

confirm that this effect may also be beneficial in the specific case of the tourism sector. Polo et al. [11] confirm that spatial concentration favors the creation of a competitive climate that makes companies have a greater tendency to adopt a more market-oriented strategy. For his part, Yang [46,56] demonstrates that Chinese tourism has formed the agglomeration phenomenon through the formula to improve the productivity of production factors.

Although the different benefits that companies can obtain from concentrating on space have been listed, it should not be forgotten that this greater concentration of companies can also produce a series of disadvantages when a certain level of tourist intensity is reached. In fact, the research carried out by Baum and Haveman [57] and Ingram and Inman [58] identifies that there is an inverted U relationship between the current number of competitors and the entry of new participants, which the authors attribute to the deterrent effect produced by an excessive level of competition. On the other hand, it should not be forgotten that developing a sustainable tourism model entails not exceeding certain levels of tourist pressure that could generate inadequate resource management. The impact of tourism tends to occur when more tourists visit a place that it can sustain; therefore, knowing and identifying how much and when an attraction is visited helps to design solutions to avoid the potential negative social, environmental or cultural impacts that exceeding the tourist load threshold may entail [59].

In view of the data presented, the need to know how tourism activities are distributed in a region is reflected in order to be able to carry out realistic planning, which, on one hand, will enhance the positive externalities that may arise from tourism concentration while on the other hand its possible negative effects are minimized. This importance is increased when it comes to emerging destinations, where in addition to planning their tourism strategy, it is necessary to create infrastructure in addition to a series of investments that will help guide the growth path of this sector, especially when the tourism products on offer suggest the need for creating a sustainable development model, as is the case of the region that concerns us in this research, Extremadura in Spain.

With reference to this region, different analyses have been carried out that have confirmed that tourist activity tends towards concentration in space, which favors the creation of certain clusters or hotspots, or indeed cold spots, which must be analyzed and understood for the correct management of the activity [13,14,60–64].

The present study proposes the continuation of advancement along these lines, empirically evaluating said spatial trends in order to propose a modelling that allows for the characterizing, mapping and measuring of the different spatial structures and the organization of activities in space in order to provide a practical tool for both the public and private management of tourist activity in the region.

The next section gives a description of the region under study that allows the reader to contextualize the results obtained and also synthesize the previous results achieved in the study of the pattern of tourist activities in the region of Extremadura.

3. Case Study: Extremadura

The region of Extremadura located in the southwest of the Iberian Peninsula (see Figure 1) stands out for having a vast territory, with its two provinces (Badajoz and Cáceres) being the largest in Spain and with a low population density of only 27 inhabitants per km^2. It is, therefore, an inland region that, due to its endowment of natural resources and heritage, has enormous potential to base its development model on highly sustainable tourism products. Despite this, it can be considered that its tourism sector is still in a growth phase, driven by the need to diversify the economic activity of the region heavily dependent on livestock and agriculture, which makes it the Spanish region with the lowest GDP per capita [65].

Considering its tourist activities, it should be noted that its unfavorable economic context has made the region a priority objective of the European aid programs LEADER (Liaisons entre Activités de Development de L'Economie Rural), LEADER II, and PRODER (Programa Operativo de Desarrollo y Diversificación de Zonas Rurales) which have developed among its priority objectives the diversification of agricultural income through the development of tourism.

These grants, together with the expansionary growth policies implemented by the regional administration, have caused a noticeable increase in the number of lodging facilities in the region, especially in the case of rural tourism. As can be seen in Table 1, the region had a total of 1591 accommodation units at the beginning of 2019 providing a total of 40,947 places, of which just over half correspond to rural tourism establishments.

Figure 1. Location of area of study.

Table 1. Tourism Magnitude of Extremadura (year 2019).

Type of Accommodation	Number of Establishments	Number of Places
Hotels	451	19,268
Non-hotels	343	13,301
Rural	797	8,378
Total	1591	40,947

Source: Registry of Companies and Tourist Activities of Extremadura.

However, this increase in accommodation capacity has not been accompanied by a strong increase in the number of travelers visiting the region, which means that the tourism sector is characterized by strong imbalances between supply and demand. In addition, the growth in the accommodation capacity has not been evenly distributed over the territory, which generates the need to investigate the pattern of tourism activity in the region in order to be able to carry out joint planning of the territory that allows the monitoring and planning of this activity so as to achieve its optimal development.

For this reason, different studies have been focused on creating knowledge of the pattern that the tourist sector draws in the territory of Extremadura. The work of Nieto and Cárdenas [64] included a study examining how the materialization of the investments made by the LEADER programs in the region between the years 2000 and 2013 have been distributed; they found that their distribution has a strong tendency to concentrate on high values, the north being one of the main beneficiary areas of the same.

Other studies have concentrated on examining the pattern drawn by tourist sites in the region of Extremadura. Sánchez [60] focuses on analyzing how tourist sites are distributed in the region, both accommodation and restaurants. Among his main conclusions, it is noteworthy that while hotel places tend to be concentrated in the three main cities of Badajoz, Cáceres and Mérida, those of rural accommodation are located in the north of the region (Jerte and La Vera) and also in the territory of Tajo Internacional-Sierra de San Pedro and around the Monfragüe Biosphere Reserve National Park.

On the other hand, he finds that that the premise that the distribution of restaurant places follows a random pattern in space which cannot be ruled out. (see Figure 2).

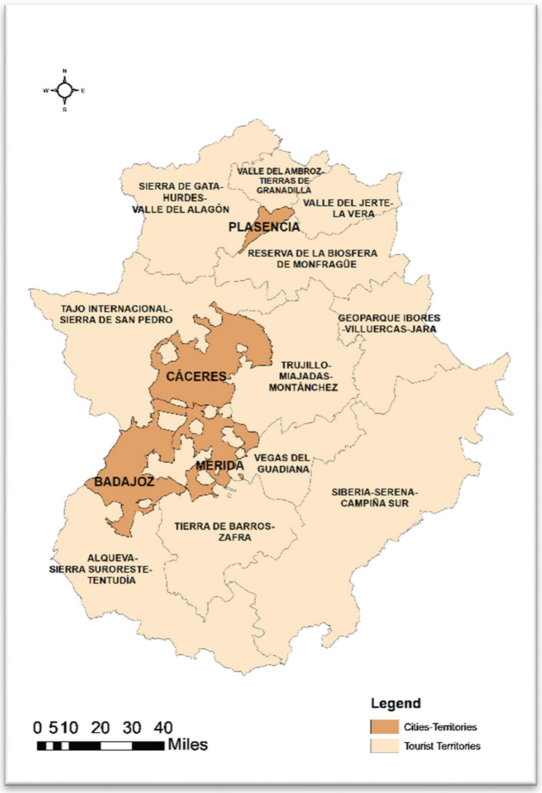


Figure 2. Maps of tourist territories of Extremadura.

Taking as a reference the number of places offered by accommodation in the region, Sánchez et al. [62] likewise analyzed the distribution and evolution of the places offered in the region between 2004 and 2014. Their results identify a cluster in the north of the region and also in the three main cities of the region, although with a different level of significance. The distribution of rural accommodation places was subsequently studied in isolation, with high value clusters being identified in the territories of La Vera, Zafra-Río Bodión, Vegas Altas, and the vicinity of Alange, and others of low value located in the territories of Montánchez, Sierra de Gata, and Jerte (see Figure 2).

The number of accommodation establishments were also analyzed; two quadrants with a high degree of tourist intensity have been identified, one in the micro-territories of Plasencia, Jerte-La Vera and the Ambroz Valley, and the second in the vicinity of the city of Cáceres and Monfragüe Natural Park [66] (see Figure 2).

From a demand perspective, different studies have also been carried out to confirm that its distribution also tends towards concentration in space. Rodríguez and Sánchez [13] analyze the pattern presented by the travelers visiting the region; they found a trend towards their concentration in the three main cities of the region. The efficiency of tourist sites is subsequently analyzed from a spatial perspective, using the level of occupancy as a proxy indicator of the satisfactory adjustment between supply and demand. The results achieved allow us to identify three clusters with a satisfactory level of adjustment between supply and demand in the three main cities of the region and also two low-value clusters with the greatest imbalances between supply and demand in the territories of the Villuercas-Ibores-Jara Geopark and the Trujillo-Miajadas-Montánchez Geopark [14] (see Figure 2).

In view of all these results, it is evident that both the distribution of supply and demand in the region under study present strong territorial imbalances that must be analyzed for the proper monitoring of the activity if we are to propose adequate planning for the tourism development in the region adapted to visitors' specific needs

4. Methodology

In this paper, intensity is defined as the average density of points in space, i.e., the expected number of points per unit area [67]. This intensity may be constant for every unit area (uniform intensity or Complete Spatial Randomness, CSR) or may vary from location to location (inhomogeneous intensity). This intensity is modelled as a Poisson process with the parameter $\lambda(u,x\backslash$, where x is a spatial point pattern and u is a location. This parameter represents the conditional intensity of the spatial process.

The simplest way to model this conditional intensity in a loglinear form is as follows:

$$\lambda(u,x\backslash = \exp(\theta_0) \quad (1)$$

in which θ_0 is a constant. This means that intensity does not depend on the location of the point pattern. This parametrization of the intensity is equivalent to a stationary Poisson process (complete spatial randomness) [68].

If the Poisson process is not homogeneous, then the conditional intensity will depend on the location of the point pattern (a nonstationary Poisson process). The location u is determined by the X coordinate (longitude) and/or by the Y coordinate (latitude) of each spatial point. When the conditional intensity depends on the location, it is possible to speak of a "spatial trend". The estimation of the trend best fitted to the observed spatial points is the objective of this applied research. When the intensity of a Poisson process varies spatially, this intensity is modelled as a log- linear function of the geographic coordinates, that is, $ln\lambda(u,x) = f(x; y)$. Log-linearity is a natural assumption in this case, because it ensures that intensity is a non-negative quantity, and it is the canonical link for Poisson data [69]. Furthermore, this log-linear modeling can capture non-linear relationships between intensity and x,y coordinates.

If the spatial trend depends only on the longitude, the conditional intensity is defined as follows:

$$\lambda(u,x) = \exp(\theta_0 + \theta_1 x) \quad (2)$$

in which θ_0 and θ_1 are scalar parameters to be fitted and x is the longitude Cartesian coordinate. This means that the conditional intensity varies from East to West or vice versa.

If it is considered that the spatial trend depends on the latitude, then the conditional intensity is modelled as follows:

$$\lambda(u,x) = \exp(\theta_0 + \theta_2 y) \quad (3)$$

in which y is the latitude Cartesian coordinates. In this case the conditional intensity varies from North to South or vice versa.

It is possible to consider also that both longitude and latitude determine the spatial trend of the Poisson process. If this is the case, the following spatial trend could be proposed:

$$\lambda(u,x) = \exp(\theta_0 + \theta_1 x + \theta_2 y) \quad (4)$$

In Expression (4), it is assumed that the conditional intensity may vary not only from East to
West but also from North to South or vice versa.

In the previous models, a linear relationship between the conditional intensity and the location (coordinates x and y) is assumed. In many cases however (especially in spatial clusters) this relationship could be not linear. This could be due to the fact that, in a portion of the territory there is a high concentration of accommodation, the fit of a linear trend would not be adequate, while a non-linear trend could better fit to this concentration. A polynomial function of degree r could then be used to model the spatial trend.

The first polynomial stationary model that can be proposed is that in which the conditional intensity is related only to the longitude of the point pattern through a quadratic function, i.e.,

$$\lambda(u,\mathrm{x}) = \exp(\theta_0 + \theta_1 x + \theta_3 x^2) \quad (5)$$

If, on the contrary, the conditional intensity is related only to the latitude, the quadratic function to model it is as follows:

$$\lambda(u,\mathrm{x}) = \exp(\theta_0 + \theta_2 y + \theta_4 y^2) \quad (6)$$

Finally, if the relationship between the conditional intensity and both Cartesian coordinates in a non-stationary Poisson process is quadratic, the intensity could be defined as follows:

$$\lambda(u,\mathrm{x}) = \exp(\theta_0 + \theta_1 x + \theta_2 y + \theta_3 x^2 + \theta_4 y^2 + \theta_5 xy) \quad (7)$$

Of all these models, the only "pure" Poisson model is model 1 (which does not include either spatial trends or mark dependencies). The rest of the models (model (2) to model (7)) are, in fact, Gibbs point processes [70,71]. These Gibbs point models relax the independence assumption by assuming interactions between set of points. In addition, these models allow the inclusion of spatial trend and dependency on marks [72].

To estimate all these models, a maximum pseudo-likelihood method [73] for Poisson models

[74] is used with the Huang–Ogata improvement [75] is used.

Once the model is estimated, it must be validated by checking that the model is a good fit for the data and that all terms in the model are appropriate. In order to do so, residuals from the satisfactory model (the differences between observed and expected values) can be calculated [76–78]. These residuals can be represented in a diagnostic plot to assess goodness-of-fit, to identify outliers in the data, to reveal departures from the fitted model, etc.

Finally, and due to the maximum pseudo-likelihood being equivalent to the maximum likelihood for Poisson processes [69], nested models (one model is a special case of another) can be compared using a composite likelihood ratio test [79]. Given the two nested models (model 0 is the "smaller" one, i.e., the simpler model; 1 is the "greater" one, i.e., the model with more parameters), and defining the null hypothesis as "the smaller model is the best model", this test is defined as follows:

$$\Lambda = 2\log\frac{\mathrm{CL}(\bar{\theta}_1, x)}{\mathrm{CL}(\bar{\theta}_0, x)} \quad (8)$$

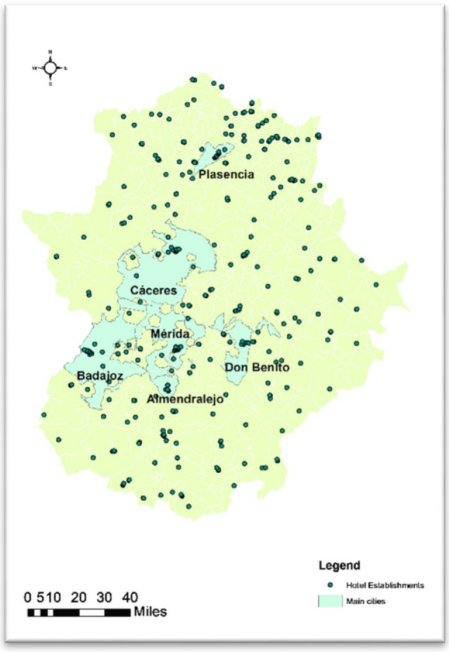
in which $\mathrm{CL}(\bar{\theta}_0, x)$ are the maximum composite likelihood estimates of θ under the smaller model and $\mathrm{CL}(\bar{\theta}_1, x)$ are the maximum composite likelihood estimates of θ under the greater model. Λ has an asymptotic χ^2 distribution with d degrees of freedom, in which d is the difference in the number of parameters for the two models. If the value of Λ is large (i.e., p-value below level of significance), the null hypothesis should be rejected. This means that the greater model fits the data better than the smaller one.

5. Results

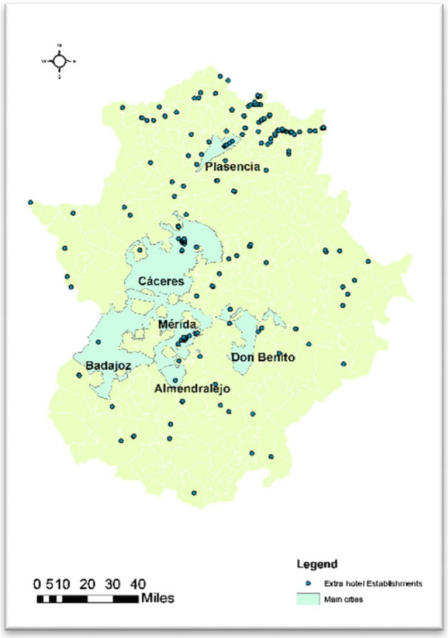
The spatial point patterns analyzed in this article are the total number (whole population) of hotels, non-hotel establishments and rural accommodation establishments located in Extremadura on 1 January 2019 (1591 spatial points). The spatial representation of these three types of establishments is shown in Figure 3. The Coordinate Reference System used in this research is EPSG (European Petroleum Survey Group): 4326—WGD84. It is important to note that in Figure 3, the longitude (X axis) takes values between −7.55° and −4.75° and the latitude (Y axis) takes values between 37.9° and 40.5°. These values represent the respective minimum and maximum of the geographical coordinates of the region of Extremadura. This means that all the 1591 spatial points are represented in Figure 3 (spatial points are not excluded in this representation).

To identify possible differences in the estimated values of the models presented earlier in the methodology section, a covariate (factor) representing the type of accommodation was introduced. This factor has three levels: hotel establishments (hotels, hostels, pensions, and apartment hotels), extra-hotel establishments (tourist apartments, tourist camps, and lodges) and

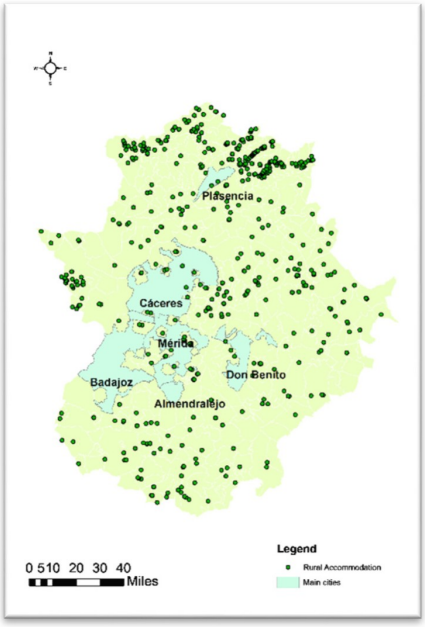
rural accommodation (rural hotels, *casas rurales*, and rural apartments). The total number of spatial points analyzed is 451 hotel establishments, 343 extra-hotel establishments, and 797 rural accommodation establishments. In this way it has been possible to obtain the estimated values of these three types of accommodation.



(a)



(**b**)



(**c**)

Figure 3. Spatial representation of types of accommodation establishments in Extremadura. (**a**) Hotel establishments. (**b**) Extra-hotel establishments. (**c**) Rural accommodation.

The first model to provide an estimate is the stationary Poisson process (model (1)). The results of the estimation of the model (1) are shown in Table 2. It can be observed that the intercept of the model is statistically significant for the three types of establishment. The

estimated value of the conditional intensity, according to this model, reaches a value of 61.9 hotel establishments, 47.1 extra- hotels establishments, and 109.5 rural accommodation establishments per unit area. However, the higher concentration of certain establishments observed in the northern third of the region (mainly rural accommodation) and the lower concentration in the southeast quadrant of the region (see Figure 3) suggest that this stationary model is not the most suitable for modelling accommodation distribution establishments in Extremadura.

Compared with model (1), model (2) incorporates the possible influence of the longitude (X coordinate) to estimate the conditional intensity. However, this coordinate is not statistically significant for the three types of establishment (p-values higher than 0.05 in all cases) (see Table 3). As a consequence, the conditional intensity of accommodation establishments in Extremadura does not depend (at least linearly) on the longitude, which means that there does not seem to be a greater concentration of hotels, extra-hotel establishments, or rural accommodation establishments when moving from east to west through the region or vice versa. This situation may be due to the fact that the main tourist resources in the region (specially, Zafra, Mérida, Cáceres, Trujillo, Plasencia, Monfragüe and Valle del Jerte), road infrastructures (highway A-66) and the most populated cities (Cáceres, Mérida and Plasencia) are located in the geographical center of the region (without there being a greater or lesser concentration of establishments to the East or West of this geographical center) in a strip that crosses the region from North to South, or vice versa (around the A-66 highway).

Table 2. Estimation of model (1) $\lambda(u,x) = \exp(\theta_0)$.

(a) **Global Estimation (Total Population)**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	5.3870	0.0251	5.3379	5.4361	214.8726	0.0000
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−0.5694	0.0589	−0.6849	−0.4539	−9.6631	0.0000
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−0.8431	0.0646	−0.9997	−0.7166	−13.0562	0.0000
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	4.6957	0.0354	4.6263	4.7651	132.5659	0.0000

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

Table 3. Estimation of model (2) $\lambda(u,x) = \exp(\theta_0 + \theta_1 x)$.

(a) **Global Estimation (Total Population)**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	5.5773	0.1918	5.2013	5.9533	29.0751	0.0000
θ_1	0.0309	0.0310	−0.0298	0.0918	0.9990	0.3178
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−1.1913	0.4516	−2.0764	−0.3062	−2.6379	0.0083
θ_1	−0.1015	0.0729	−0.2444	0.0415	−1.3911	0.1642
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−1.4981	0.4954	−2.4691	−0.5270	−3.0237	0.0025
θ_1	−0.1068	0.0799	−0.2635	0.0499	−1.3364	0.1814
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	5.2028	0.2699	4.6739	5.7318	19.2797	0.0000
θ_1	0.0828	0.0439	−0.0032	0.1688	1.8872	0.0591

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of the parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

This does not, however, hold true when instead of conditioning the estimated intensity of accommodation establishments to longitude, it is conditioned to latitude (coordinate Y). As can be seen in Table 4, it is very clear that the Y parameter is statistically significant for all types of establishments. This means that the latitude of the location of the accommodation establishments of the region determines their concentration (intensity).

Incorporating the X coordinate, model (4) (with estimates presented in Table 5) into model (3) does not substantially improve the theoretical model adjustment to the observed distribution of the three types of spatial points being analyzed. It was already commented (model (2)) that the X coordinate is not statistically significant in this case; this is also true when estimating the same coordinate in model (4).

Table 4. Estimation of model (3) $\lambda(u,x) = \exp(\theta_0 + \theta_2 y)$.

(a) **Global Estimation (Total Population)**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-vaLue
θ_0	−19.6440	1.4108	−22.4091	−16.8789	−13.9242	0.0000
θ_2	0.6357	0.0357	0.5658	0.7056	17.8209	0.0000
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	31.1094	3.2770	24.6866	37.5322	9.4933	0.0000
θ_2	−0.8022	0.0831	−0.9650	−0.6394	−9.6591	0.0000
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	9.7399	3.7433	2.4032	17.0767	2.6020	0.0093
θ_2	−0.2671	0.0945	−0.4523	−0.0819	−2.8261	0.0047
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−32.4629	2.1501	−36.6771	−28.2487	−15.0980	0.0000
θ_2	0.9418	0.0542	0.8357	1.0480	17.3854	0.0000

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of the parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

Table 5. Estimation of model (4) $\lambda(u,x) = \exp(\theta_0 + \theta_1 x + \theta_2 y)$.

(a) **Global Estimation (Total Population)**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−19.4537	1.4235	−22.2438	−16.6636	−13.6657	0.0000
θ_1	0.0310	0.0310	−0.0298	0.0918	0.9992	0.3167
θ_2	0.6357	0.0357	0.5658	0.7056	17.8209	0.0000
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	30.4875	3.3074	24.0051	36.9699	9.2179	0.0000
θ_1	−0.1015	0.0729	−0.2444	0.0415	−1.3911	0.1642
θ_2	−0.8022	0.0831	−0.9650	−0.6394	−9.6591	0.0000
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	9.0851	3.7754	1.6854	16.4847	2.4064	0.0161
θ_1	−0.1068	0.0799	−0.2635	0.0498	−1.3364	0.1814
θ_2	−0.2671	0.0945	−0.4523	−0.0819	−2.8260	0.0047
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−31.9557	2.1667	−36.2024	−27.7090	−14.7484	0.0000

θ_1	0.0828	0.0439	−0.0032	0.1688	1.8874	0.0591
θ_2	0.9418	0.0542	0.8357	1.0480	17.3854	0.0000

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of the parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

Model (2) postulates a linear relationship between longitude and the conditional intensity of accommodation establishments in Extremadura, while model (5) (estimates for which are presented in Table 6) postulates a quadratic relationship. As is noted, the quadratic term in the model is statistically significant in the case of extra-hotel establishments and rural accommodation, but not in the case of hotel establishments (at a 5% level of significance). Therefore, the longitude must be incorporated into the model in a quadratic and not in a linear manner when modelling intensity in extra-hotel establishments and rural accommodation establishments.

In model (6), the latitude is the coordinate that has been entered into the non-stationary Poisson model in a quadratic manner. All the parameters of this model are statistically significant for the three types of accommodation at a 5% level of significance (see Table 7). Therefore, the relationship between latitude and the conditional intensity of accommodation establishments in the region could be quadratic in some cases.

Incorporating the information provided by models (5) and (6) into a single model, model (7) was proposed as the final one. Table 8 shows the estimates for this quadratic model for the three types of establishment. All the parameters of this model are statistically significant at a 1% level of significance. In this manner, the best possible fit for the XY coordinates of the accommodation establishments analyzed is obtained in a single model.

Table 6. Estimation of model (5) $\lambda(u,x) = \exp(\theta_0 + \theta_1 x + \theta_3 x^2)$.

(a) **Global Estimation** (Total Population)						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−72.6416	3.0781	−78.6746	−66.6085	−23.5992	0.0000
θ_1	−25.7337	1.0059	−27.7054	−23.7621	−25.5817	0.0000
θ_3	−2.0994	0.0819	−2.2599	−1.9388	−25.6289	0.0000
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−14.6098	6.9978	−28.3253	−0.8943	−2.0877	0.0368
θ_1	−4.3359	2.2829	−8.8105	0.1386	−1.8993	0.0575
θ_3	−0.3315	0.1856	−0.6952	0.0321	−1.7867	0.0740
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−65.7370	10.8322	−86.9678	−44.5061	−6.0686	0.0000
θ_1	−20.8973	3.5225	−27.8014	−13.9933	−5.9325	0.0000
θ_3	−1.6735	0.2858	−2.2336	−1.1134	−5.8564	0.0000
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−60.2502	3.8558	−67.8074	−52.6929	−15.6257	0.0000
θ_1	−21.5681	1.2665	−24.0504	−19.0858	−17.0295	0.0000
θ_3	−1.7702	0.1036	−1.9732	−1.5671	−17.0893	0.0000

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of the parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

Table 7. Estimation of model (6) $\lambda(u,x) = \exp(\theta_0 + \theta_2 y + \theta_4 y^2)$.

(a) **Global Estimation (Total Population)**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	p-Value
θ_0	−785.5298	91.5826	−965.028	−606.031	−8.5772	0.0000
θ_2	39.5602	4.6514	30.4437	48.6767	8.5051	0.0000

θ_4	−0.4944	0.0590	−0.6101	−0.3787	−8.3731	0.0000
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-Value
θ_0	−859.7298	213.2334	−1277.659	−441.799	−4.0319	0.0000
θ_2	44.6835	10.8492	23.4195	65.9475	4.1186	0.0000
θ_4	−0.5804	0.1380	−0.8509	−0.3100	−4.2068	0.0000
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-Value
θ_0	−2073.040	300.0644	−2661.156	−1484.925	−6.9087	0.0000
θ_2	105.4399	15.2073	75.6340	135.2458	6.9334	0.0000
θ_4	−1.3409	0.1927	−1.7185	−0.0963	−6.9603	0.0000
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-value
θ_0	−304.3357	129.0645	−557.2976	−51.3739	−2.3580	0.0184
θ_2	14.7380	6.5468	1.9065	27.5696	2.2512	0.0244
θ_4	−0.1750	0.0830	−0.3377	−0.0023	−2.1079	0.0350

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of the parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

Table 8. Estimation of model (7) $\lambda(u,x) = \exp(\theta_0 + \theta_1 x + \theta_2 y + \theta_3 x^2 + \theta_4 y^2 + \theta_5 xy)$.

(a) Global Estimation (Total Population)						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-Value
θ_0	−1139.59	101.6837	−1338.9	−940.3	−11.2072	0.0000
θ_1	−56.1434	3.9503	−63.8859	−48.4008	−14.2123	0.0000
θ_2	48.8087	4.9353	39.1356	58.4818	9.8896	0.0000
θ_3	−2.2017	0.0854	−2.3690	−2.0345	−25.7966	0.0000
θ_4	−0.5542	0.0607	−0.6732	−0.4353	−9.1326	0.0000
θ_5	0.7373	0.0892	0.5624	0.9122	8.2630	0.0000
(b) **Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-Value
θ_0	−1120.26	239.3995	−1589.475	−651.0467	−4.6795	0.0000
θ_1	−26.3308	9.2414	−44.4437	−8.2180	−2.8492	0.0044
θ_2	53.8047	11.6214	31.0273	76.5822	4.6298	0.0000
θ_3	−0.4672	0.1959	−0.8511	−0.0832	−2.3849	0.0171
θ_4	−0.6555	0.1429	−0.9355	−0.0375	−4.5881	0.0000
θ_5	0.5220	0.2085	0.1134	0.9306	2.5040	0.0123
(c) **Extra-Hotel Establishments**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-Value
θ_0	−2717.49	358.2552	−3419.660	−2015.326	−7.5854	0.0000
θ_1	−74.1553	15.4549	−104.4464	−43.8642	−4.7982	0.0000
θ_2	126.4228	17.0084	93.0869	159.7586	7.4330	0.0000
θ_3	−1.9685	0.3102	−2.5764	−1.3605	−6.3459	0.0000
θ_4	−1.5080	0.2050	−1.9097	−1.1062	−7.3559	0.0000
θ_5	1.2555	0.3438	0.5818	1.9293	3.6523	0.0000
(d) **Rural Accommodation**						
Parameter	Estimate	S.E.	CI95.lo	CI95.hi	Z value	*p*-Value
θ_0	−524.5467	138.0345	−795.0894	−254.0040	−3.8001	0.0001
θ_1	−40.2522	4.9010	−49.8580	−30.0646	−8.2130	0.0000
θ_2	19.6935	6.7744	6.4159	32.9712	2.9070	0.0036
θ_3	−1.8108	0.1055	−2.0175	−1.6041	−17.1712	0.0000
θ_4	−0.2022	0.0841	−0.3670	−0.0374	−2.4054	0.0161
θ_5	0.4583	0.1132	0.2364	0.6803	4.0476	0.0000

Notes: S.E: Standard error. CI95.lo: lower limit of the 95% confidence interval of the parameter estimation. CI95.hi: higher limit of the 95% confidence interval of the parameter estimation. Source: own work.

Once all the previous models are estimated, and in order to determine which of them best fits the spatial point patterns observed, the composite likelihood ratio tests of different nested models are calculated. The results of these calculations are shown in Table 9.

Table 9. Composite likelihood ratio tests (comparison between nested models).

Comparison of Models	Λ	d.f.	*p* Value
(1) vs. (2)			
Total population	0.9982	1	0.3177
Hotel establishments	0.1032	1	0.7480
Non-hotel establishments	0.1307	1	0.7177
Rural accommodation	3.5639	1	0.0590
(1) vs. (3)			
Total population	339.1	1	0.0000
Hotel establishments	4.9335	1	0.0263
Non-hotel establishments	81.754	1	0.0000
Rural accommodation	346.64	1	0.0000
(2) vs. (4)			
Total population	339.1	1	0.0000
Hotel establishments	4.9335	1	0.0263
Non-hotel establishments	81.754	1	0.0000
Rural accommodation	346.64	1	0.0000
(3) vs. (4)			
Total population	0.9987	1	0.3176
Hotel establishments	0.1032	1	0.7480
Non-hotel establishments	0.1310	1	0.7174
Rural accommodation	3.5669	1	0.0589
(2) vs. (5)			
Total population	1116.1	1	0.0000
Hotel establishments	316.75	1	0.0000
Non-hotel establishments	396.34	1	0.0000
Rural accommodation	451.33	1	0.0000
(3) vs. (6)			
Total population	76.162	1	0.0000
Hotel establishments	53.074	1	0.0000
Non-hotel establishments	105.32	1	0.0000
Rural accommodation	4.5855	1	0.0322
(4) vs. (7)			
Total population	1265.2	3	0.0000
Hotel establishments	404.72	3	0.0000
Non-hotel establishments	533.36	3	0.0000
Rural accommodation	472.83	3	0.0000

Source: own work.

Initially, the stationary Poisson model (1) and the non-stationary Poisson model (2) were compared. This is because we wished to determine whether the conditional intensity $\lambda(u,x)$ depends on the longitude of each spatial point pattern. As can be seen, the likelihood ratio test is not statistically significant at 5%, which means that model (2) is not significantly better than model (1) for any type of establishment. Consequently, the intensity of the accommodation establishment does not seem to depend linearly on the longitude, so it can be said that there is no greater or lesser concentration of establishments as we move from the west to the east of the region or vice versa.

On the contrary, when comparing the stationary Poisson model (1) with the non-stationary Poisson model (3), it was confirmed that the likelihood ratio test is statistically significant at a 1% level of significance for non-hotel establishments and rural accommodation establishments, and at a 5% level of significance for hotel establishments. Consequently, it can be said that model (3) fits the observed spatial point patterns better than model (1). It can therefore be concluded that the conditional intensity $\lambda(u,x)$ depends linearly on the latitude associated with spatial point patterns. In other words, the intensity of accommodation establishments varies as we move from north to south of the region or vice versa.

In order to confirm that the Y component (latitude) of the geographical location of the accommodation establishments determines their conditional intensity, the non-stationary model (2) was compared with non-stationary model (4). While the first of these models considers that $\lambda(u,x)$ depends only on longitude, model (4) assumes that it depends on both longitude and latitude. The likelihood ratio test results indicate that the latter model fits the observed spatial point patterns significantly better than the former. Therefore, the latitude of these spatial points determines the conditional intensity, a situation that does not occur when longitude is considered.

As a complement to the previous analysis, nested models (3) and (4) are compared considering the initial scenario in which $\lambda(u,x)$ depends exclusively on latitude; a final scenario is reached in which it is supposed that the conditional intensity also depends on longitude. In this case, the model that incorporates both coordinates is not significantly better than the model only including the Y coordinate. This conclusion is valid for the three types of establishment. The longitude of each spatial point does not therefore contribute in linear terms to the modelling of the conditional intensity of the accommodation establishments located in Extremadura.

From the comparison of the first four models proposed, it can be concluded that the best of all is model (3). However, this model assumes that the relationship between $\lambda(u,x)$ and the Y coordinate of each spatial point pattern is a linear relationship. Especially when particularly high concentrations of accommodation establishments occur, it is possible for this relationship to be not linear but rather of a polynomial nature (for example, the relationship between the conditional intensity and geographic coordinates may be quadratic).

To test whether this relationship is linear or not, model (2) was compared to model (5). The first postulates a linear relationship between conditional intensity and the longitude of spatial points. As can be seen, model (5) generates an adjustment to the observed data significantly better than model (2). This means therefore that the influence of the X coordinate on $\lambda(u,x)$ is better captured by the model including the quadratic term the one that only captures the linear relationship.

The result is similar when the nested models (3) and (6) are compared. The likelihood ratio test result indicates that model (6) provides a better fit than model (3) for the three types of establishments. Consequently, the relationship between conditional intensity and latitude is better captured by the model including the quadratic term the one that only captures the linear relationship. Finally, and to confirm the quadratic relationship between the conditional intensity and the XY coordinates of the spatial point patterns analyzed, model (4) was compared with model (7). While model (4) establishes an exclusively linear relationship between the $\lambda(u,x)$ and Y coordinate, model (7) postulates a quadratic relationship. In this case, if the likelihood ratio test results are observed, it can be concluded that model (7) significantly improves the fit to the observed spatial point patterns compared with model (4).

Consequently, of all the models proposed, model (7) is best fitted to the observed location of the accommodation establishments in Extremadura. This is to such an extent that Figure 4 shows the observed intensity (left) and the expected intensity according to model (7) (right) for hotel and extra- hotel establishments and for rural accommodation establishments. The great similarity between both graphs confirms that the selected model (7) allows the spatial distribution of the accommodation establishments in Extremadura to be very closely modelled.

All calculations in this paper were made with the R package "spatstat" [80]. The point process models estimated in spatstat are Gibb point processes [70,71,81].

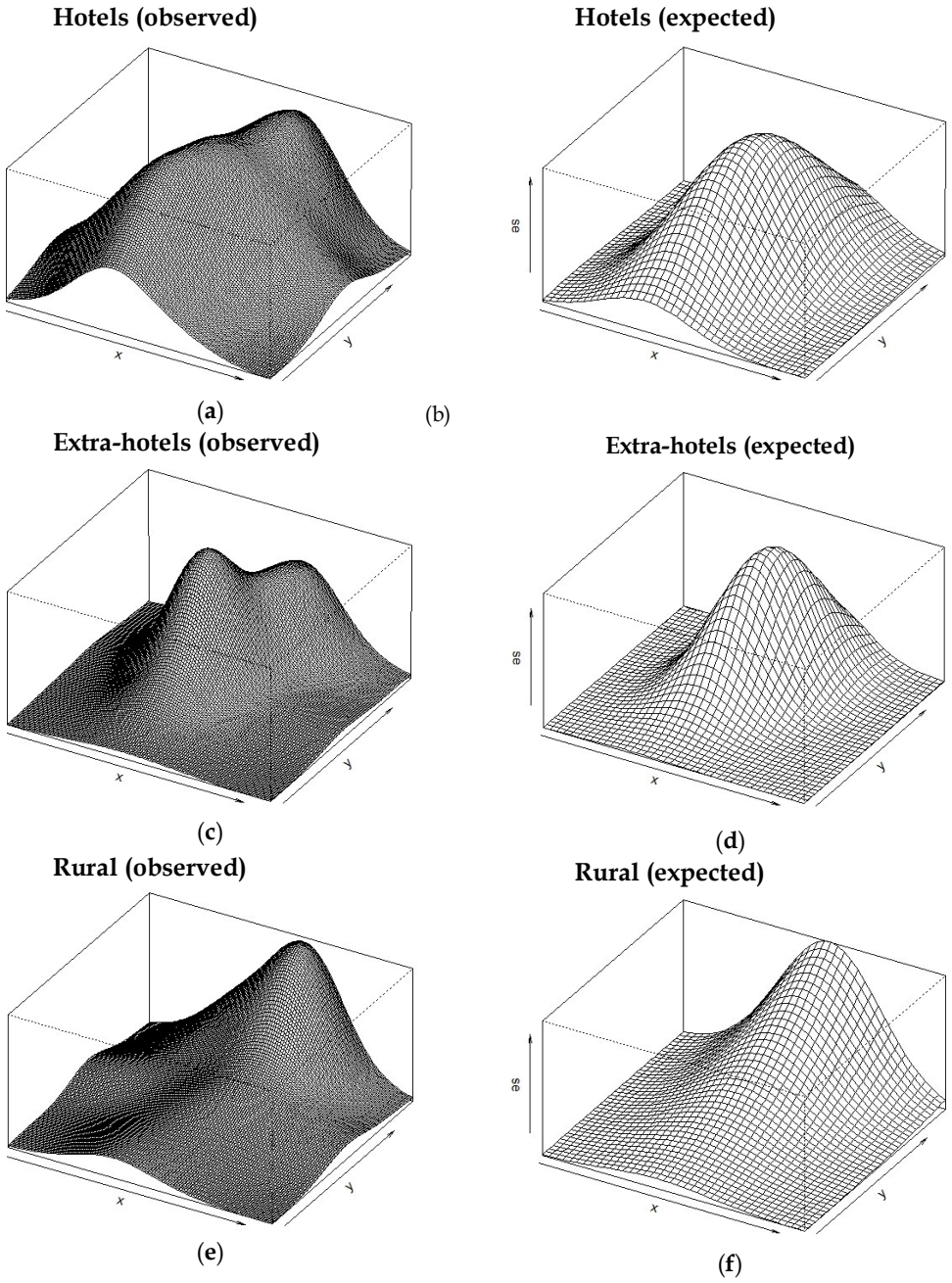


Figure 4. Comparison between the observed (**left**) and the expected (**right**) spatial pattern under model (7) of accommodation establishments in Extremadura (**a**) Hotels (observed) (**b**) Hotels (expected) (**c**) Extra-Hotels (observed) (**d**) Extra-Hotels (expected) (**e**) Rural (observed) (**f**) Rural (expected).

6. Discussion and Conclusions

The interaction of tourism and space achieves special relevance in the field of tourism activity planning and management. The planning processes of the tourism sector need to have exhaustive information that allows the different agents involved to make decisions based on the situation of the sector. In this sense, incorporating information on the distribution patterns of tourist activity in the territory allows for more efficient management of resources, favoring certain positive synergies such

as those derived from agglomeration economies, and managing and minimizing possible negative impacts such as the saturation of the destination or excess competition.

This trend takes the form of the proliferation of studies which, through the conjunction of GIS (Geographic Information Systems) and proprietary techniques of spatial statistics, seek to explain how tourist variables are distributed in space, proposing different theoretical or empirical models that allow operationalization decision-making in relation to different areas of tourist activity, considering their interaction with space.

The present work begins with the aim of proposing a model with a satisfactory level of adjustment with the existing pattern of points in Extremadura. It is an inland region which is in a stage of expansion, and based on the identification of different previous studies, this presents a series of imbalances that deserve to be analyzed for the proper planning of the evolution and needs of the sector. The authors therefore consider that modelling this pattern can be a valuable tool for public– private sector management.

After proposing and estimating different models considering the intensity of accommodation conditioned by longitude and latitude, it was found that the model which best fits the reality of the region is to show that tourist intensity is in a quadratic relationship with latitude and longitude for the three types of accommodation used to carry out this research.

Knowing the model that best explains the geographical location of the supply of the accommodation establishments in a tourist destination is essential in both public and private tourism management. The creation of accommodation infrastructure in a destination must always start from a previous premise: these infrastructures are not equally necessary throughout the destination. It is only when the intensity of these infrastructures is spatially homogeneous throughout the entire territory of the destination that the opening of new tourist accommodation is equally successful regardless of where it is located. However, this situation of spatial homogeneity is unusual at tourist destinations, since the usual scenario is that there are spatial concentrations in the supply of tourist accommodation, especially around tourism resources and products offered by the destination. For this reason, modelling the intensity of accommodation at a destination is a preliminary step in determining whether the location chosen for the opening of new establishments is the most appropriate.

From the perspective of the public tourism administration, the aid granted for the creation of tourism infrastructure in general and accommodation infrastructure in particular hardly ever takes into account the influence of the location on the suitability of that new infrastructure. Providing financial aid to create a new offer of accommodation in spaces where there is a high concentration of establishments (observed values higher than expected ones) only contributes to increase competition between the accommodation establishments located in that space. On the contrary, the location in spaces with a deficit of accommodation (observed values lower than expected ones) can help to create tourism development which currently does not exist, owing to a lack of infrastructure among other things.

In addition, considering the characteristics of the objective territory in which natural resources constitute an important claim for the satisfactory operation of the tourism sector, it is essential to create a sustainable development model that allows for the correct exploitation of its resources while guaranteeing their preservation. In this sense, monitoring those areas with the highest tourist intensity will be essential in order to guarantee that the tourist carrying capacity that can be associated with the territory is not exceeded for proper resource management.

Furthermore, from the perspective of private entrepreneurship, knowledge of the focus of business concentration at the destination is vital information when it comes to guiding investments. In those areas of the territory that are considered "tourist deserts" due to the limited offer of accommodation and complementary services (probably due to their low tourist attraction), investment groups will therefore not be interested in investing in the creation of tourist infrastructure, since it is very probable that the low tourism activity compromises the economic profitability of the project. On the contrary, in the spaces of the territory in which there is a high concentration of tourist accommodation and a complementary supply ("tourist oasis"), investment will be much more

attractive given that the existence of scale economies between companies and complementary services will guarantee a minimum economic return that will encourage investment in the area.

In this way, the research carried out in this paper has an unquestionable practical use as ignoring the spatial distribution of the accommodation supply in a destination can lead, in most cases, to incorrect political and business decisions.

Having a model in which one can estimate the expected number of accommodation establishments that should be in a specific geographical space from the coordinates of longitude and latitude of that space and comparing it with the actual (observed) number of accommodation establishments is a very valuable tourism management tool which should be considered by all tourist destinations.

As a future line of research, and as there is no evidence of the existence of similar studies in destinations comparable to that analyzed, it would be interesting to extend this modelling proposal to other territories to confirm whether similarities exist that can be understood as characteristics of inland destinations in a stage of growth. On the other hand, although the present work focused on proposing a model that, by means of the position of each one of the accommodations that make up the accommodation plant in the region, allows us to describe how these accommodations are distributed in the region object of study in an operational way, it would be interesting in future works to be able to include other covariates that can help explain the identified spatial distribution pattern, such as income level, prices, or proximity to communication routes, at the same time that it allows the suggestion of development possibilities depending on the endowment of available resources.

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4. RESUMEN DE PRINCIPALES RESULTADOS Y CONCLUSIONES

RESUMEN PRINCIPALES RESULTADOS Y CONCLUSIONES

La presente tesis doctoral parte con el objetivo de proponer, aplicando técnicas propias de estadística espacial, un modelo empírico que presente un buen grado de ajuste al patrón espacial de la actividad turística observado en el ámbito territorial de la región de Extremadura. Tal y como señala Anselin (1998) la aplicación de técnicas de estadística espacial junto con los Sistemas de Información Geográficos (GIS), permite extender las fronteras de los tipos de análisis desarrollados en un entorno realista lo cual puede suponer un apoyo importante en el estudio de políticas o toma de decisiones. Por ello, se considera que el modelo propuesto puede suponer una valiosa herramienta para la gestión público-privada de la actividad turística en la región objeto de estudio.

Proponer una modelización que se ajuste al patrón de distribución espacial observado de los alojamientos turísticos en la región requiere, en primer lugar, tener un conocimiento lo más exhaustivo posible sobre el mismo. Por este motivo, previo a la labor de la tarea de modelización, la presente tesis doctoral realiza un análisis exploratorio espacial de las principales variables turísticas que permiten caracterizar al turismo en la región de Extremadura.

Para ello, en primer lugar, se selecciona como variable de interés una de las que puede considerarse como más representativa asociada al comportamiento de la demanda, el número de viajeros llegados a la región. Los resultados obtenidos como consecuencia de este primer análisis se encuentran recogido en el capítulo uno, y nos permiten confirmar que la distribución espacial global de la demanda turística en la región está caracterizada por la existencia de una fuerte tendencia a la concentración espacial de valores altos de la variable. Además, la tendencia identificada no se mantiene constante en las diferentes tipologías analizadas (hoteleros versus no hoteleros), por tanto, se pone de relieve la necesidad de realizar análisis desagregados a nivel tipología para obtener un conocimiento más preciso del comportamiento espacial de la actividad turística.

Por otra parte, el análisis a nivel local de la demanda permite identificar que el conjunto total de viajeros llegados a la región tiende a concentrarse en las tres principales ciudades: Badajoz, Cáceres y Mérida. Estos resultados presentan similitudes en línea con los obtenidos en investigaciones previas, como los trabajos desarrollados por Yang y Wong (2013) que constatan la tendencia a la concentración de la demanda, para el caso del estudio de China, en las principales áreas de costa, regiones montañosas, ciudades que actúan como puerta de entrada

y aquellas de mayor jerarquía. Las tres ciudades identificadas podrían ser incluidas en esta última opción, ya que se trata de las dos ciudades capitales de cada una de las provincias de la región, y de la capital de la misma, por tanto, se aprecian ciertas similitudes con el patrón identificado en otros destinos.

Sin embargo, cuando se analiza la distribución espacial a nivel desagregado, en función del tipo de alojamiento, los resultados no permanecen estables. Así, para el caso particular de los alojamientos hoteleros el patrón de la demanda viene justificado por la mayor contribución de las tres principales ciudades antes mencionadas. En cambio, cuando se analiza a nivel local, la distribución de los viajeros alojados en establecimientos no hoteleros se identifica una serie de clusters de valores altos ubicados en el norte de la región.

Los resultados obtenidos como consecuencia de este primer análisis nos permiten alcanzar una serie de conclusiones interesantes para la gestión de la actividad turística del destino. Por una parte, se pone de manifiesto la necesidad de realizar análisis desagregados de la distribución espacial, ya que el tipo de alojamiento afecta al patrón espacial dibujado. Por otra parte, se confirma que a nivel demanda existe una marcada tendencia a la concentración espacial, por tanto, esta característica podría ser aprovechada por los gestores de destino para realizar planificación de territorios más amplios beneficiándose, de esta forma, de las economías de escala. Finalmente, con la aplicación del análisis a nivel local se consigue identificar aquellas unidades espaciales que presentan unos valores de las variables mayores a los esperados en una distribución aleatoria, por tanto, los gestores de destino se pueden beneficiar de este conocimiento realizando una labor de monitorización y gestión de los microdestinos identificados acorde a las características y necesidades presentes en cada uno de ellos.

Completar una visión en su conjunto del comportamiento de la actividad turística requiere considerar variables que puedan ser representativas tanto de la oferta como de la demanda. Por este motivo, para seguir avanzando en el conocimiento espacial que caracteriza a la actividad turística en la región se decide efectuar el análisis de una variable representativa en su conjunto de la actividad, el grado de ocupación. Esta variable viene definida como el cociente entre las plazas efectivamente ocupadas de entre aquellas que son ofertadas para un espacio concreto, por ello, en el capítulo dos esta variable es analizada como indicador proxy de la eficiencia de las plazas turísticas existentes en la región.

La región extremeña ha basado tradicionalmente sus políticas de crecimiento en un modelo expansivo, lo que ha provocado fuertes desequilibrios entre oferta y demanda. Por este motivo, se considera que las técnicas de estadística espacial pueden constituir un valioso aliado

de cara a poder establecer análisis a nivel microterritorio que permitan corregir los posibles desequilibrios detectados. Se considera, por ende, que realizar este análisis representa una valiosa fuente de información de cara a poder realizar una correcta planificación y monitorización de la actividad turística.

Los resultados obtenidos a nivel global confirman la existencia de una fuerte tendencia a la concentración de la variable en valores altos, es decir, las plazas que resultan más eficientes tienden a estar agrupadas en el espacio. Por su parte, cuando se realiza el estudio a nivel local se obtienen una serie de clusters que contribuyen a esta tendencia a la concentración actuando con signo contrario. De un lado, se identifican tres clusters que presenta valores altos de las variables ubicados, nuevamente, en las tres principales ciudades de la región. De otro lado, se diagnóstica la presencia de dos clusters cuyas plazas presentan un significativo desequilibrio entre oferta y demanda, siendo los dos territorios que presentan grados de ocupación por debajo de los valores que cabría esperar si estuviéramos ante un caso de distribución aleatoria de la variable en el espacio, los territorios de Geoparque Villuercas-Ibores-Jara y Trujillo-Miajadas-Montánchez, ubicados en la parte este de la provincia de Cáceres.

Por lo tanto, los resultados obtenidos nos permiten confirmar las sospechas iniciales de desequilibrios territoriales existentes por el diferente ritmo de crecimiento entre oferta y demanda que ha marcado la tendencia de crecimiento de la actividad turística en la región. A nivel local, la identificación de un conjunto de alojamientos que presenten un comportamiento análogo permite la creación de clusters que puedan ser monitorizados para establecer, en base de este análisis, las líneas estratégicas de actuación necesarias para que las plazas turísticas puedan cumplir de un modo más eficiente con la función para las que fueron creadas. Además, nuevamente se confirma en esta variable una fuerte tendencia a la concentración, por lo que se constata que esta tendencia es característica, en su conjunto, de la actividad turística y no exclusiva de la demanda. Por tanto, la gestión de esta actividad permite aprovechar las sinergias y economías de escala de una planificación de territorios amplios que presenten comportamientos análogos.

Los resultados obtenidos hasta el momento se orientan a marcar una tendencia en la distribución de alojamientos que no se corresponde con la que cabría esperar en un escenario de distribución aleatoria de los mismos. Pero hay que destacar que esta contrastación se ha realizado, hasta este momento, de forma exclusiva mediante el empleo de medidas de asociación espacial. Estas medidas presentan como principal debilidad una fuerte dependencia de la división territorial y el criterio de vecindad utilizado y, por este motivo, los resultados

podrían estar condicionados por la opción seleccionada al establecer cada uno de los criterios anteriormente mencionados, por lo que resulta aconsejable la contrastación de la tendencia identificada mediante técnicas estadísticas alternativas.

Por ello, en el capítulo tres se busca esta contrastación complementaria mediante la estimación de una función de intensidad turística por el empleo de tres métodos alternativos: conteo de cuadrante, función K(r) de Ripley y suavizado de la función de densidad de Kernel. Por otra parte, una vez contrastada la no aleatoriedad en la distribución de los alojamientos en la región, se persigue obtener conocimiento sobre la estructura espacial identificada de cara a poder utilizar dicha información para proponer el modelo que mejor se ajusta al patrón de distribución espacial observado.

Con respecto a los principales resultados obtenidos tras la realización del análisis descrito se obtiene, de una parte, que la distribución observada de los alojamientos turísticos se encuentra más agrupada de lo que cabría esperar en una distribución aleatoria, con una intensidad turística que disminuye en el espacio analizado de norte a sur. Por otra parte, atendiendo al estudio del patrón identificado cabe señalar la existencia de dos cuadrantes en los que se observa una mayor intensidad turística de la esperada ante un escenario de distribución espacial aleatoria.

El primero de los cuadrantes queda constituido por tres microdestinos ubicados en el norte la región: la ciudad de Plasencia y los territorios del Jerte-La Vera y Valle de Ambroz. El segundo de los cuadrantes, por su parte, se corresponde con la ciudad de Cáceres y el Parque Natural de Monfragüe. Se observa, por tanto, que los resultados obtenidos confirman, parcialmente, los hallazgos alcanzados en investigaciones previas con la identificación de una mayor intensidad en el norte de la región. Por lo que se alcanza el objetivo de confirmar la no aleatoriedad espacial por técnicas alternativas, obteniendo dicha confirmación por los tres métodos utilizados para la estimación de la función de intensidad.

Una vez concluido el análisis exploratorio espacial de las principales magnitudes turísticas de la región, los resultados alcanzados reflejan diversos aspectos. De un lado, se obtiene que no se puede afirmar que las variables turísticas en la región extremeña obedezcan a un patrón aleatorio en su distribución espacial, sino que forman determinados regímenes y asociaciones que deben ser tenidos en cuenta para una correcta gestión de esta actividad. Por otro lado, se constata que la tipología de alojamiento podría estar influyendo en los patrones identificados sugiriendo, por tanto, que es posible alcanzar un conocimiento más exhaustivo de la actividad si se realizan análisis desagregados por tipología de alojamientos de la distribución

espacial. Además, se confirma la existencia de una tendencia general de las variables turísticas a concentrarse en el espacio en valores altos. Por último, se detectan determinadas agrupaciones que invitan a pensar que la posición en el espacio, longitud y/o latitud, puede estar influyendo en la tendencia espacial identificada, ya que, excluyendo las principales ciudades, las mayores concentraciones de la actividad se encuentran ubicados en el norte de la región.

Sin entrar a valorar qué factores pueden estar influyendo en que la actividad presente este patrón, ya que la naturaleza de este estudio es más descriptiva que explicativa, una vez se ha alcanzado este grado de conocimiento del sector turístico se procede a proponer una modelización que permita sintetizar de forma operativa los principales hallazgos alcanzados en el análisis espacial de la actividad turística en la región de Extremadura.

Para ello, en el capítulo cuatro se modela la intensidad turística mediante un proceso de Poisson en el que la intensidad turística se encuentra condicionada por la localización en el espacio (longitud y latitud), considerando, además, las tres principales tipologías de alojamientos existentes en la región: alojamientos hoteleros, extrahoteleros y rurales. Tras comprobar el grado de ajuste de diferentes modelos se procede a compararlos con el fin de poder hallar cuál de ellos consigue el mejor grado de ajuste con un menor número de parámetros a considerar. Finalmente se obtiene que, de entre los diferentes modelos propuestos, el que presenta un mejor grado de ajuste para las tres tipologías analizadas es aquel que modela mediante una función cuadrática la intensidad condicionada tanto por la longitud como por la latitud en el espacio.

La principal novedad de los hallazgos alcanzados mediante la realización de la presente tesis doctoral es que ésta constituye, a menos que los autores tengan conocimiento, la primera propuesta formal de una modelización que permita mostrar de forma operativa la tendencia espacial observada en la distribución de los alojamientos turístico en la región de Extremadura. Se trata de una región que, por sus peculiares características, requiere una intensa labor de planificación y gestión de la actividad que le permita, de un lado, dotar de infraestructuras necesarias a una región en fase de crecimiento de su actividad turística y, de otro lado, corregir, mediante una adecuada gestión, los desequilibrios creados como consecuencia del modelo de crecimiento expansivo utilizado.

De manera detallada y, en aplicación al destino en particular observado, la puesta al servicio del turismo de las técnicas de estadística espacial ha permitido extraer una serie de implicaciones que pueden sintetizarse en las siguientes:

- ✓ La región de Extremadura, como ya se ha indicado, puede ser caracterizada como una región de interior que posee una amplia extensión geográfica y cuenta con un sector turístico aún en fase de crecimiento o expansión. Por ello, conocer cuál es el patrón de distribución de la actividad, identificado aquellas zonas que poseen una mayor intensidad turística, permitirá a las administraciones públicas realizar una adecuada dotación de infraestructuras, así como la mejora del transporte o de servicios sociales, entre otros, en aquellos microterritorios en los que sea más necesario.
- ✓ Mediante el análisis exploratorio espacial de la actividad turística se ha confirmado la existencia de una fuerte tendencia a la concentración espacial lo que implica que las variables turísticas sufren un efecto contagio. Esta tendencia puede producir numerosos beneficios, como marcan las teorías de economías de aglomeración, al tiempo que ofrece la posibilidad de realizar una planificación de territorios más amplios aprovechando el efecto sinergia y las economías de escala.
- ✓ El modelo expansivo de crecimiento de la oferta turística en la región ha producido una serie de desequilibrios entre oferta y demanda que deben ser corregidos para una adecuada gestión de la actividad. Por este motivo, conocer cuál es la tendencia espacial, identificando agrupaciones de alojamientos que presenten un comportamiento análogo permite realizar una monitorización de los mismos, para establecer las líneas de actuación necesarias para conseguir los objetivos perseguidos por cada microterritorio en función de sus particulares características, necesidades y potencialidades.
- ✓ Respecto a la iniciativa privada, obtener información territorial detallada a nivel microterritorio representa una valiosa herramienta para la toma de decisiones, en general, y para una de las más importante de las empresas turísticas en particular, la decisión de localización. Por ello, conocer aspectos tan esenciales como el nivel de intensidad competitiva, la dotación de infraestructuras existentes o la distribución de la demanda en el espacio, entre otros, supone una valiosa fuente de información.
- ✓ Por otra parte, el turismo en la región de Extremadura se basa en el desarrollo de productos en torno a sus dos principales activos, naturaleza y cultura. Ambas tipologías turísticas precisan desarrollar modelos de desarrollo sostenibles que permitan la explotación económica de los recursos al tiempo que se asegura la preservación de los mismos. En este sentido, el análisis de la distribución turística

requiere ser realizada a nivel local con el fin de poder detectar las debilidades a subsanar en cada microterritorio al tiempo que se supervisa que no se esté excediendo la capacidad de carga que permita conseguir el desarrollo sostenible del microdestino.

Como puede verse, son diversas las aplicaciones que el conocimiento exhaustivo de las variables turísticas considerando su componente espacial puede representar para la adecuada gestión de un destino, por ello, se considera que los resultados alcanzados mediante el presente trabajo de investigación suponen una valiosa herramienta para la gestión público-privada del destino Extremadura.

Para concluir es preciso aclarar que, como cualquier trabajo de investigación, la presente tesis doctoral suscita nuevas interrogantes que sería interesante poder abordar como futuras líneas de investigación de cara a seguir generando conocimiento para la gestión de la actividad turística en Extremadura. En sentido, y dada la naturaleza exploratoria de esta investigación, sería interesante indagar más sobre la causa del patrón identificado, incluyendo en futuras investigaciones covariables que puedan a ayudar a explicar dicha tendencia, como el nivel de ingresos, los precios o a la proximidad a las principales vías de comunicación o principales mercados emisores, entre otros aspectos.

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