# Green Destination Recommender: A Web Application to Encourage Responsible City Trip Recommendations


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## ABSTRACT

Tourism Recommender Systems (TRS) have evolved from only providing user recommendations to becoming convergence points for multiple stakeholders. This necessitates recognizing the interests of all stakeholders, particularly in the tourism sector, which faces challenges like seasonality and resource constraints. Our stakeholder classification identifies consumers, item providers, platform, and society as key stakeholders, highlighting the complexity of real-world relationships. Fairness in TRS demands a multistakeholder approach, integrating sustainability to address the broader societal impact.

While research has focused on fair recommendation systems in tourism, the focus on generating sustainable recommendations remains limited. This demo paper aims to enhance fairness in TRS, mainly focusing on society as a stakeholder. We introduce the Green Destination Recommender (GDR), an application that prioritizes Societal Fairness (S-Fairness) by encouraging environmentally conscious decisions. GDR recommends sustainable tourism destinations based on the user's starting location, travel month, and specific interests. The application promotes ecologically friendly options by recommending less popular yet appealing destinations, considering the emissions from transport to reach the destination and the seasonal demand to balance visitor numbers year-round.



## KEYWORDS

Tourism Recommender Systems, Sustainability, Multistakeholder Fairness, Societal Fairness

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## 1 INTRODUCTION

Tourism Recommender Systems (TRS) have been actively assisting in trip planning by providing personalized recommendations for accommodations, activities, destinations, and more [16]. Traditionally, their focus had been primarily on providing accurate user recommendations. However, today, they function as a convergence point for multiple stakeholders, resulting in a multistakeholder scenario [1]. Thus, recognizing the interests of all stakeholders is essential in navigating this dynamic landscape, particularly in the tourism sector, which poses many challenges due to factors like seasonality, travel regulations, and resource constraints such as airline tickets and hotel rooms [3].

Our stakeholder classification is influenced by Balakrishnan and Wörndl [3], which identifies four key stakeholders: consumers, item providers, platform, and society. Despite this apparent simplicity, real-world stakeholder relationships often prove to be more complex when the goals of one stakeholder conflict with those of another, resulting in inevitable trade-offs [17]. Hence, achieving fairness in TRS demands a multistakeholder approach in its design, development, and evaluation, ensuring equitable consideration for all parties in a given context.

The influence of tourism reaches beyond its immediate stakeholders, affecting passive participants such as the environment, local businesses, and residents. A TRS must consider promoting sustainable options and encouraging responsible tourism practices. The World Tourism Organization and the United Nations Development Programme define *sustainable tourism* as an approach that considers current and future economic, social, and environmental impacts, addressing visitors' needs, the industry, the environment, and host communities [13]. Integrating sustainability with TRS has led to developing systems recommending environmentally friendly destinations, points of interest (POIs), accommodations, and modes of transport, among other factors.

While there has been a substantial amount of research on developing fair recommendation systems that consider the interests of all stakeholders involved in tourism [22–25], the focus on generating sustainable recommendations remains limited [5]. This paper aims to enhance fairness in TRS, particularly considering society as a crucial stakeholder. This approach ensures fairness by addressing the concerns and feedback of the broader society, such as the local businesses, residents, and environment, which, while not directly engaged in the travel activities, is nonetheless impacted by them. Achieving fairness within this framework should not only satisfy the needs of society as a stakeholder but also balance these with the interests of item providers and consumers [3, 7].

In this demo paper, we introduce Green Destination Recommender (GDR). This application prioritizes Societal Fairness (*S-Fairness*) [8] by encouraging users to make environmentally conscious decisions while providing vacation recommendations. Our

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web application assists travelers in finding sustainable tourism destinations for their vacation based on their starting location, preferred travel month, and specific interests (e.g., historical, educational, culinary, etc.). It suggests cities aligning with the sustainability criteria measured by the destination's popularity, seasonal demand, and emissions from various transport options used to reach the destination from the user's starting location. Here, we use the terms *"cities"* and *"destinations"* interchangeably to refer to our item space for recommendations.

Existing work on TRS encompasses a variety of platforms and features aimed at providing personalized travel suggestions, understanding user decision-making in sustainable TRS [7], and recommending environmentally friendly accommodations [10–12]. However, to our knowledge, web applications that allow users to prioritize sustainable destinations by integrating various sustainability features into a single metric is a novel concept. To this end, the application makes the following contributions:

- Promoting environmentally friendly options by recommending destinations with lower $CO_2$ emissions to support sustainable travel practices.
- Directing tourists towards less popular yet appealing destinations to distribute tourist traffic evenly and boost interest in lesser-known locales.
- Selecting destinations with seasonal demand considerations to balance visitor numbers throughout the year, avoiding overtourism during peak times and preventing undertourism during off-peak periods.

## 2 GREEN DESTINATION RECOMMENDER

In this section, we outline the main features of our application (Section 2.1), take a detailed look at the user interface (Section 2.2), discuss the datasets utilized (Section 2.3), and provide the technical specifications required (Section 2.4) for the application demo.

### 2.1 Generating Sustainable Recommendations

The Green Destination Recommender (GDR) allows users to explore sustainable vacation destinations. Users can select their starting location from a curated list of 160 European cities, specify their preferred travel month, and indicate interests such as history, culture, and cuisine related to the destination. Upon inputting these preferences, the application generates a list of cities sorted by default in ascending order of an overall sustainability score, known as the *S-Fairness Indicator* [6]. This score is calculated relative to the user's starting point using a weighted sum of the following metrics:

- emissions estimated for reaching the destination from their selected source using the most eco-friendly means of transport (*emissions index*),
- popularity of the destination (*popularity index*), and
- how crowded the destination is for the selected month (*seasonality index*).

A lower overall score for a city indicates a more environmentally friendly travel option from the user's starting point. Displaying the *S-Fairness Indicator* for specific tourist destinations offers a tangible insight into their sustainability status, promoting responsible tourism practices essential for the well-being of communities and the environment [6]. In addition, we use specific highlighting labels such as *"green recommended"*, *"lowest emission"*, *"hidden gem"*, or *"least crowded"* to denote the most sustainable options. This labeling is done to nudge the user to select a greener alternative.

### 2.2 User Interface Design

We structure the application along two principal pages — "*Home*" and "*Explore*" as seen in Figure 1. Each page and its components are designed to provide a cohesive, user-friendly experience, guiding users through discovering and selecting sustainable travel destinations. The interface combines aesthetic appeal with functionality, ensuring users can easily navigate the application, access detailed information, and make informed decisions aligned with their sustainability values.

*2.2.1 Home Page.* The home page in Figure 1b serves as the entry point for users, providing a simple, intuitive interface to input their departure city and, optionally, their preferred travel month and specific interests. The page also includes a brief overview of the application's research objectives, guiding users to understand the purpose behind the application.

*2.2.2 Explore Page.* The explore page in Figure 1a is the central component of the application. It displays a list of potential destinations sorted by their overall *S-Fairness Indicators*, which indicate their sustainability levels. Detailed information about each destination is provided, encompassing the overall *S-Fairness Indicator*, $CO_2$ emission offset, popularity, seasonality, available transportation options with corresponding emissions and durations, and standard details such as destination name, country, image, category, and description. The overall *S-Fairness Indicator* and its component for each destination — emissions for various modes of transport, popularity, and seasonal demand follow the traffic light color scheme adhering to a well-established user experience design principle [19]. We indicate the most sustainable options in *green*, the neutral choices in *orange*, and the least sustainable alternatives in *red*. This color scheme ensures that users can quickly grasp the sustainability levels of different components within the application. We tag the overall *S-Fairness Indicator* scores ranging from 0 to 20 with a *green* label, highlighting them as more sustainable choices. Scores between 20 and 40 receive an *orange* label, while the scores of 40 and above, representing the least sustainable options, are marked with a *red* label.

Emissions for flights, driving, and trains are listed in ascending order, with the most environmentally friendly option highlighted in green to encourage users to consider more sustainable transportation choices. Moreover, the application allows users to filter and sort the list of destinations based on their preferences, such as the overall *S-Fairness Indicator*, minimum $CO_2$ emission required over all three transportation options, popularity, and seasonality indices. Initially, the top three results, sorted from most sustainable to least sustainable, are displayed, with the option to load additional results if desired. This feature prioritizes eco-friendly choices, subtly encouraging users to opt for these over less sustainable alternatives.

Although the default display is the card view, users can easily toggle between the card view (Figure 1a) and map view (Figure 1c) on this page. The application retains the user's current sorting preference from the previous view. The map view shows all potential destinations with color-coded markers reflecting the sorting criteria, ranging from *green* (most sustainable) to *red* (least sustainable). It is also accompanied by a legend for clarity. Clicking a marker reveals a side panel with the same detailed information in the card view. Additionally, users can customize the sorting order based on their preferences for individual components of the overall score, such as emissions, popularity, or seasonal demand, similar to the card view. The map view enhances the user experience by providing a visually intuitive way to explore and select sustainable travel destinations.

### 2.3 Data Integration

Our data collection is guided by the methodology outlined in Banerjee et al. [6]. We leverage a publicly available dataset of 160 European cities [4] for potential starting locations and generating recommended results. To calculate popularity indices, we utilize data from Tripadvisor [1] to collect the number of attractions in each city. These counts are then normalized between *zero* and *one* to establish relative popularity compared to other cities. The lower the popularity index score, the less popular the destination. The application aims to encourage users to choose less popular but attractive destinations, promoting a balanced and sustainable tourism experience. We classified the cities in the bottom 44 percentile of the popularity index score as *"rare find"* and tagged them with a *green* label. The destinations with the next 44-88 percentile are labeled as *"rising"* and are tagged with a *yellow* label. Those with popularity index values between 88–95 percentile are assigned a *"traffic"* label, marked in *orange*. Finally, destinations in the top 5 percentile are labeled as *"hotspot"* and marked with *red*.

To estimate the monthly seasonal demand, we utilize normalized visitor counts per month sourced from TourMIS [2] for cities where such data is accessible. However, when TourMIS data is unavailable, we adopt an alternative approach by utilizing the normalized average price of Airbnb [3] listings. This substitution is necessary due to the limited availability of TourMIS data, which covers only a few cities. The lower the seasonality index score, the less crowded the destination is for the month, indicating a more sustainable trip to that destination. Similar to the popularity index classification, the bottom 49 percentile of the seasonality indices were tagged as *"quiet"* with a *green* label. The destinations with seasonality index values between 49–82 percentile were denoted as *"off-peak"* and tagged with a *yellow* label. Those with seasonality index values between 82–98 percentile, are assigned a *"busy"* label, marked in *orange*. Finally, the top 2 percentile of the scores are categorized as *"crowded"* with a *red* label. However, it is essential to note that the categorization of both popularity and seasonality labels depends on the distribution of the data. This categorization may also vary in less sparse data distribution with more uniform data points.

We utilize Google Flights [4], Google Maps API [5], and Deutsche Bahn API [6] for obtaining flight, driving, and train connections, respectively between the cities. While Google Flights and Google Maps API cover extensive regions across Europe, the train data is currently restricted to cities in Germany and neighboring countries served by Deutsche Bahn (German railways). For estimating $CO_2$ emissions, we refer to the estimations proposed by Graver et al. [14] for flights, Hilali and Belmaghraoui [15] for gasoline-powered medium-sized cars, and Larsson and Kamb [18] for fully electric trains operating in Europe. The categorization of interests into different categories is performed manually with an expert's assistance and a large language model.

### 2.4 Technical Specifications

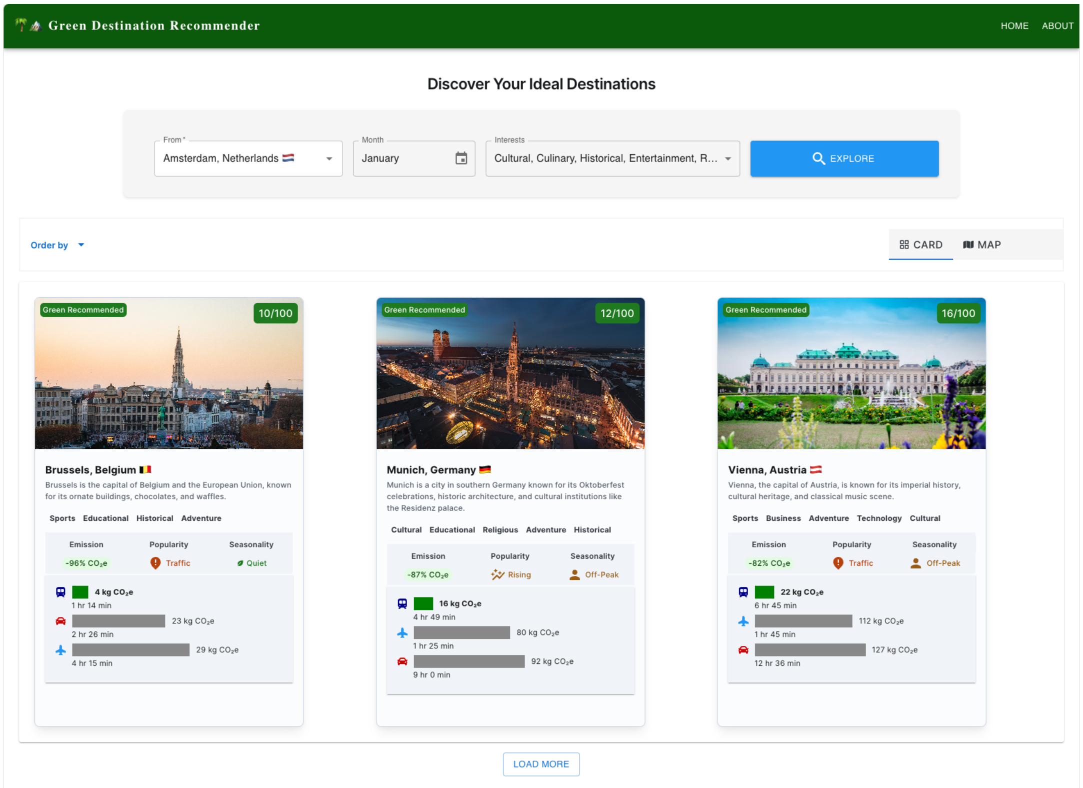
The GDR application is built using React [7], a robust library for web and mobile interfaces, which is complemented by Material UI [8] for enhanced design and responsiveness. We use Leaflet [9], an open-source JavaScript library for the interactive map features. Python is used for data integration, processing, and consolidation, resulting in a JSON output for streamlined data handling. The project's source code is stored on GitHub for managing versions and facilitating collaboration. Firebase Hosting [10] is used for deployment, connected to GitHub Actions (CI/CD) for automatic deployment. The images of the cities are stored and retrieved from Firebase Storage. The application aims to deliver a uniform user experience and maintain responsiveness across various mobile phones, tablets, and laptops, supporting diverse screen sizes and resolutions. The application can be accessed via the URL: https://gdr-demo.web.app

## 3 RELATED WORK

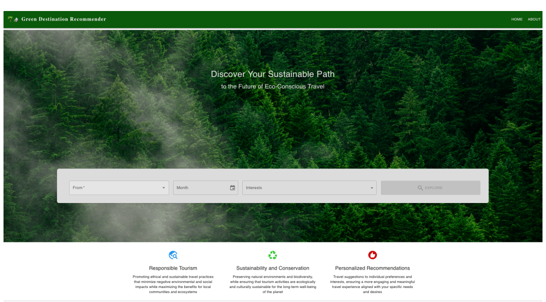
Various studies have examined TRS from diverse perspectives, addressing the needs and objectives of both consumers and providers. In addition to popular platforms such as Tripadvisor and Booking.com, Alrasheed et al. [2] propose a multi-layer TRS that utilizes user preferences to offer customized destination suggestions. This system considers factors such as travel details, budget, and individual preferences to generate a list of potential destinations preferred by similar users. Similarly, Batet et al. [9] present Turist@, a model that delivers personalized recommendations for cultural and leisure activities at the traveler's destination. This approach initially collects user preferences through a survey and continually refines them based on user interactions within the system.

Existing research has explored avenues to promote sustainable tourism and recommend eco-friendly travel destinations. For instance, platforms such as Fairbnb.coop [12] facilitate responsible and sustainable tourism by allocating a portion of their fees to local community projects chosen by travelers. On the other hand, Ecobnb [11] stands out for its focus on connecting travelers with environmentally conscious accommodation options, enforcing strict environmental standards including renewable energy usage, organic food availability, and water conservation practices. Moreover, studies by Merinov [20] investigate the negative impacts of tourist-centric approaches and propose multistakeholder strategies to manage tourist influx, aiming to balance visitor distribution across various destinations and mitigate issues like overtourism

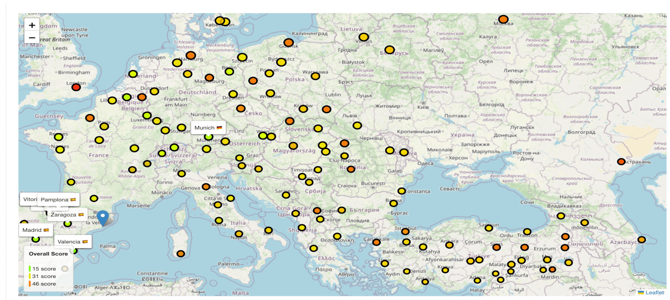
[1] https://www.tripadvisor.com/
[2] https://www.tourmis.info
[3] https://insideairbnb.com/get-the-data
[4] https://www.google.com/travel/flights
[5] https://developers.google.com/maps
[6] https://data.deutschebahn.com/dataset.groups.apis.html
[7] https://react.dev
[8] https://mui.com
[9] https://react-leaflet.js.org
[10] https://firebase.google.com




**(a) Explore Page (Card View)**




**(b) Home Page**



**(c) Explore Page (Map View)**

**Figure 1: User Interface views for Green Destination Recommender (GDR) web application.**

and undertourism. Similarly, Banik et al. [7] advocate for the integration of sustainable recommendations into TRS, highlighting their potential to guide travelers towards lesser-known yet sustainable destinations, thus addressing concerns of overtourism and undertourism. Furthermore, the "*Destination Finder*" application developed by Noubari and Wörndl [21] allows users to interactively refine their preferences using a visually intuitive map interface. Their findings highlight the importance of user-centric design and feedback mechanisms in enhancing the usability and effectiveness of such tools. To our knowledge, an interactive web application that lets users prioritize sustainable destinations by combining various sustainability features into a single metric is a new concept.

## 4 CONCLUSION

In summary, we have introduced the Green Destination Recommender, an interactive, responsive, web application designed to promote sustainable travel choices among users when selecting vacation destinations. While our system represents a step forward in encouraging environmentally conscious decision-making, it is important to acknowledge its current limitations.

Currently, the application only displays a list of sustainable destinations, along with static information on how to reach them, their popularity, and seasonality. The next phase involves integrating it with real-time data on transportation, seasonality, and other elements of sustainability. The dataset can be extended by including data from various public transport sources beyond those currently available, such as buses, carpools, and train networks outside Germany. Furthermore, we can enhance the user experience by incorporating personalization features to tailor recommendations based on individual preferences. Understanding user preferences, trade-offs, and decision-making processes will be essential in refining the application and ensuring its relevance and usefulness in sustainable tourism practices. Overall, the GDR represents a promising tool for promoting sustainability in tourism recommender systems, and future developments will strive to address its current limitations and enhance its functionality and usability.

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