A Parametric Approach Towards Carbon Net Zero in Agricultural Planning

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Abstract. This paper presents a new tool called the Space Data Generator, which is a parametric tool for organizing open spaces in rural areas. It can optimize the layout of buildings, solar panels, and agricultural planting spaces. While architects have been exploring ways to achieve net-zero carbon emissions in building design, it is equally important to attain a feasible carbon-neutral goal in rural areas. This is particularly crucial as 40% of the world's population resides in rural areas, and transitioning towards a more sustainable and efficient economy can bring about not only moral but also economic benefits through proper management [1].

The Space Date Generator offers a powerful spatial planning approach for optimizing and planning agricultural resources on any given land. This innovative tool utilizes a combination of remote sensing to generate precise maps of the land, providing a comprehensive understanding of its terrain and potential agricultural resources. With this information, farmers and land managers can make informed decisions about crop selection, irrigation, and fertilizer application, among other factors. By using the Space Date Generator, they can optimize the use of available resources and maximize crop yields, ultimately increasing profitability and sustainability in agriculture [2].

Overall, the Space Date Generator is a valuable tool for any farmer or land manager looking to make the most of their land and resources. Its ability to provide detailed and accurate data on the land's potential agricultural resources can help to streamline decision-making processes and ultimately lead to more efficient and sustainable land use practices.

1. The Space data generator uses the collected site coordinate information, geographical status (including stones, lakes, and water patterns), and the planted plants' price as input.
2. Divide the site into small squares, then configure enough solar panels in the optimal sunlight area of the site to meet the user's needs, and then plant crops on the remaining land.
3. The Space data generator will analyze the number of calories a household needs each year as a percentage. If there is a surplus, the excess food can be allocated to generate economic outcomes on the market.

The land area at hand will be subdivided based on its sun ratio, which is a relatively straightforward process. However, we are also interested in determining the value of excess vegetation that may grow in the allocated space. In this regard, the Space Data Generator can prove to be a valuable tool, not only for this particular scenario but also in other types of agricultural settings such as those involving a

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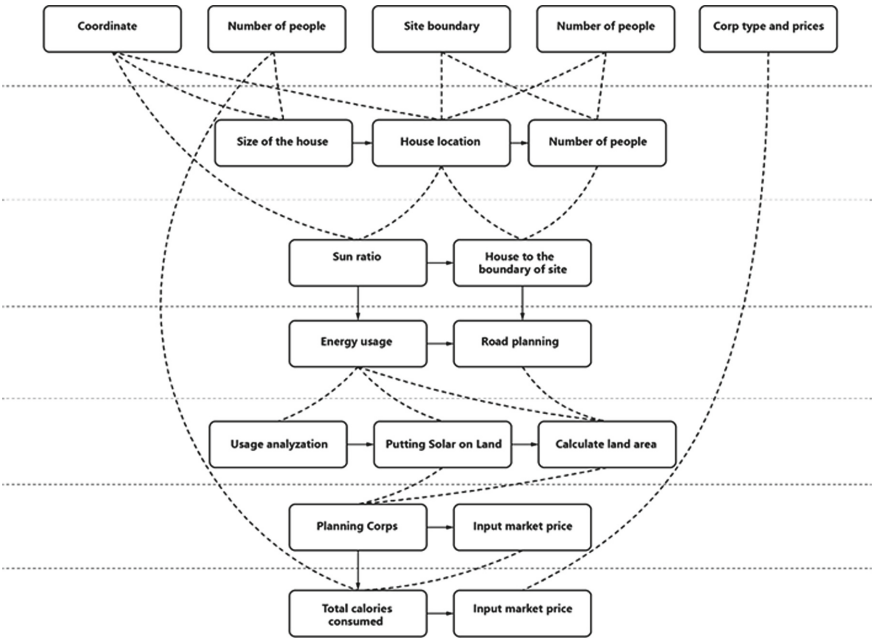
mix of livestock and crops. Additionally, it may be possible to use this tool to calculate the optimal harvesting of various plant species at different points in the seasonal cycle.

The Space Date Generator has the potential to offer valuable references for optimizing agricultural schemes. However, it must provide users with completely accurate results. Unfortunately, it currently cannot measure crucial factors such as soil type and moisture level, which are essential for agricultural planning. Despite this limitation, the Space Data Generator is a flexible tool that can be modified as research advances, allowing for more inputs to be added to improve its accuracy. Moreover, the Space Data Generator can provide guidance in various other areas based on the specific needs of the user. For instance, it can offer guidelines for traffic and urban design, among other demands. By leveraging this technology, users can access more precise and relevant information, enhancing their decision-making capabilities. As such, the Space Data Generator represents a valuable tool for various industries and sectors.

Guidelines:



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1 Background Introduction

The Space Date Generator is robust tool that can provide a comprehensive and well-thought-out analysis based on various aspects of interest. The tool takes into consideration the user's preferences in a sequential order, with a primary focus on achieving self-sufficient carbon neutrality [3].

To accomplish this goal, the tool generates a plan that fulfills each household's nutrition and electricity needs. The electricity requirement is met by the solar panel installation, while the concept of pixel farming (Fig. 1) is utilized to generate the necessary nutrition. Additionally, the tool considers adding other factors, such as planting crops or raising livestock, to fulfill economic interests. The tool also takes into account the location of existing crops and solar panels to generate the pathway closest to the edge of the field, facilitating optimized movement paths. The land usage can be edited to meet specific needs, and the tool can keep specific areas empty based on the user's preferences. However, the generated result will not defy certain conditions, such as rivers, large stones, or trees, which must remain in their original positions. The tool will adjust the result based on the existing conditions, ensuring the optimal use of the available land.

The Space Data Generator is an incredibly powerful tool that is revolutionizing the way land usage is planned and resource arrangements are optimized. Leveraging its advanced capabilities to generate optimized layouts tailored to specific parcels of land, this tool offers invaluable guidance to a diverse range of users. Whether it's individuals seeking to maximize their own land utilization or businesses looking to generate additional income streams, the Space Data Generator empowers users with insights and solutions. By using the Space Data Generator to make the most of available resources, users can not only fulfill their own needs but also contribute to the achievement of carbon neutrality. This tool offers a practical means of achieving both personal and societal goals, providing a win-win solution for anyone seeking to make the most of their land. With its potential to transform land use practices and promote sustainable development, the Space Data Generator represents a major step forward for those seeking to balance economic, environmental, and social considerations in their decision-making [4].

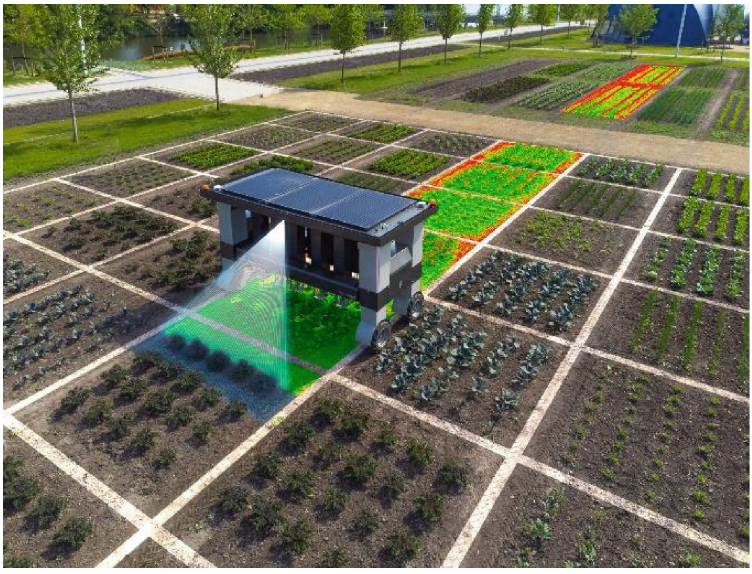

Fig. 1. The image above shows how pixel farming works in real life, image credit belongs to (Pixel farming RoboticsLaagt 164286 LV Almkerk)

2 Preconditions

The fundamental requirements for space data in the context of this program encompass a range of elements, including the site boundary and site form. These elements encompass various features such as rivers, roads, trees, and existing architecture locations, which are essential in determining the optimal placement of solar panels. Additionally, users have the flexibility to self-select other preconditions, such as house size and the number of households. Based on the energy needs of the household and taking into consideration the fact that solar energy has a higher energy conversion efficiency compared to the number of calories produced by plants for human consumption, the program automatically places solar panels in locations that are most energy-efficient.

After the solar panel is positioned, users can enter the parameters of the different types of plants they wish to grow, including energy conversion rates and market prices. The Space Data Generator then provides an overall calorie analysis based on the site conditions mentioned earlier. The analysis subtracts all the calories required by the user based on their input. If there is any surplus, the program determines how the remaining food can be sold in the market. In summary, the Space Data Generator utilizes various site-specific data to create a personalized farming plan that optimizes energy efficiency and food production. By combining user inputs with advanced algorithms, the program can help users achieve sustainable, cost-effective farming practices while simultaneously generating surplus crops for potential market sales.

3 Generating Housing Blocks

The Space Data Generator is a novel approach that utilizes the household number as input to determine the optimal house type for a specific location. This innovative system incorporates various room types that are specifically designed to accommodate a particular number of families. Additionally, the size of the household options has a direct impact on power consumption and calorie requirements, which are determined using algorithm. The house types in the Space Data Generator are carefully designed to cater to different family sizes. These house types are optimized to provide adequate space for families of varying sizes, ensuring that each family member has the appropriate amount of living space. The system takes into account the number of families in a household and determines the ideal house type that can comfortably accommodate them.

In addition to determining the appropriate house type, the Space Data Generator also considers the impact of household size on power consumption and calorie requirements. The system utilizes the algorithm that takes into account the size of the household to estimate the power consumption and calorie needs. Larger households with more families may require higher power consumption and increased calorie requirements to meet the needs of all residents. Space Data Generator is a system that combines multiple factors, including household size, house type, power consumption, and calorie requirements, to generate optimal solutions for housing in a specific location.

4 Set Building Coordinates

Once the housing block type has been generated, the Space Data generator will proceed to conduct an analysis of the optimal location to place the house on the site. To begin with, the existing site will be divided into smaller pixel blocks, and each block will be thoroughly evaluated to determine its potential for achieving optimal sunlight exposure. Safety considerations will be taken into account, and any blocks that are located adjacent to a river or the site boundary will be excluded from further consideration. Furthermore, the decision of whether to orient the house based on the direction of the sun will be left to the discretion of the user. This means that the user will have the flexibility to choose the orientation of the house that best suits their preferences and requirements. By providing this level of customization, the Space Data generator aims to ensure that the generated housing design aligns with the specific needs and preferences of the user, while also taking into account safety and environmental considerations.

Once the housing block is situated on the site, the Program will commence the process of calculating the walking paths for each household. These paths enable residents to freely navigate the site and connect to any part of it. The path determined is the shortest distance from the building to the site edge. In the case of a triangular field, there would be three paths leading to the edge of the area. Each path is perpendicular to the road's edge, which is wide enough to accommodate a car's passage. The Space Data Generator will initiate the calculation of how to maneuver around obstacles such as trees or stones.

5 Analysis of Electricity Consumption of Residential Blocks

As stated earlier, the central aim of this project is to offer a technological solution for achieving carbon neutrality. An effective architectural design can provide ethical solutions to address the changing composition of the Earth's atmosphere [5]. Additionally, we understand that the foundation of this ethical objective is to attain an excellent economic solution that yields a carbon-neutral outcome. From this perspective, if our tool can generate long-term economic benefits, it will substantially enhance the feasibility of its application across a wide range of contexts. To begin with, the Space Data Generator must allocate solar panels based on the annual electricity usage of households through calculations. This involves determining the electricity required for the "input" section of the program. Users can input their country, and the panel will display the average electricity output for that location. The program will then multiply this value by the number of households to estimate the total energy requirement by Grasshopper's Genetic Algorithm plugin [6]. The Space Data Generator will then convert this energy requirement into the number of solar panels needed, taking into account the specific efficiency of the panels being used. The default production efficiency is 250 KW/H per 3 km^2, but this value can be adjusted to meet the specific needs of the solar panels.

With this information, the program can then determine the optimal placement of the solar panels based on the available sunlight. Initially, the panels will be positioned in a three-star configuration. If this location does not meet the energy demand, the panels will be shifted to a two-star configuration. The number of stars corresponds to the amount of sunlight available in the given location. It's important to understand that

the Space Data Generator takes into account site classification based on different levels of sun intensity. Specifically, in areas with two stars, the light intensity is 75% of that in three-star areas. For instance, if 12 solar panels are installed in a three-star location, they can generate 3000 KW/H of energy. However, the same number of solar panels in a two-star location will only generate 2000 KW/H. Therefore, based on the Space Data Generator's calculations, a minimum of 16 solar panels would be required to generate sufficient electricity in this scenario.

6 Place Solar Panels

After calculating the optimal location for solar panels in each region, the algorithm proceeds to determine the maximum distance from the solar panel to the edge of the site. We acknowledge that humans have a natural inclination to establish a closer proximity to plants than to solar panels, and this has been supported by numerous research studies [10]. Once the location of the solar panels has been determined, the Space Data Generator will then calculate the most suitable land for crop placement.

7 Rating Land Type

To engage with this algorithm, the user must input their preferred type of plant. The algorithm will then automatically calculate the household's calorie consumption based on their population, and determine the total calories provided by each type of plant [7]. This will serve as a reminder for the user regarding the percentage of each plant that should be consumed yearly. It's important to note that plants will be planted on different levels of soil, where ground rated 2 to 1-star will produce much less energy compared to 3-star ground. This is due to the fact that less sunlight leads to reduced photosynthesis and calorie production.

Users can experiment with different types of plants using the simulator, which currently offers ten choices. Additionally, they can adjust the number of plants they wish to grow each year based on the simulator's generated results. Furthermore, users can select three types of crops and specify the proportion in which they would like to grow them. For instance, if the user prefers beans over rice, they can adjust the proportions accordingly. Alternatively, if there is a specific crop that is easier to cultivate or trade, users can incorporate this into their final arrangement.

8 Planting Crops

Once all inputs have been entered, the Space Data Generator will automatically calculate the user's plant consumption and provide a breakdown based on percentage. Any surplus production will be quantified in US dollars. In this scenario, the user should strive to maximize profits since all their consumption needs have been met. Therefore, careful consideration should be given to how to achieve the most profitable outcome.

9 Display

Then LDT toll will show the final room, routine, solar panel, and crop location.

10 Result

The data produced by this tool has the potential to benefit various scenarios. For instance, it could be transformed into an agricultural product or planting tool, particularly in situations where multiple types of plants need to be integrated. In order to maximize the tool's productivity, we are particularly interested in determining the optimal location for the solar panel. This will help to demonstrate the effectiveness of the tool in practice.

11 Example

Based on our analysis, we have chosen to conduct a field test of our tool in Guangdong province, specifically on a site with an expansive area of 250,000 square meters. The site includes a small forest and existing buildings, and the average household electricity consumption in the area is estimated at 10,715 kWh. Our primary requirement is to identify a sun-efficient location for the placement of the solar panels. Subsequently, roads will be constructed towards the four corners of the site to facilitate access.

In the next step of our plan, we aim to strategically position the solar panels in the most optimal area of the site, which has been rated with a three-star energy efficiency rating based on power consumption data. The energy transformation rate of the solar panels is assumed to be 15 percent, and the total energy required to meet our goals is estimated at 72,000 kWh. To achieve this, we will be utilizing a genetic algorithm, which is a computational optimization technique that can identify the optimal location for the placement of solar panels on a 100-square-meter land area, taking into consideration the three-star energy efficiency rating. This approach will enable us to maximize the energy generation potential of the solar panels and efficiently meet our energy production target (Fig. 2).

Based on the given scenario, the household's main dietary staple will be rice, with other nutritional requirements being met based on the household's needs. Considering a household size of ten people, the estimated daily consumption of rice would be approximately 9000 cal. The position of the plant will be placed by pixel farming [8], assuming an energy transformation rate of around 1 percent for rice cultivation, the total land energy required for rice production would be approximately 900,000 cal, equivalent to 1000 kilowatt-hours (KW) of energy. This would require approximately 800 square meters of land for cultivation (Fig. 3).

The remaining land can be utilized for cultivating the most cost-effective plant based on market value.

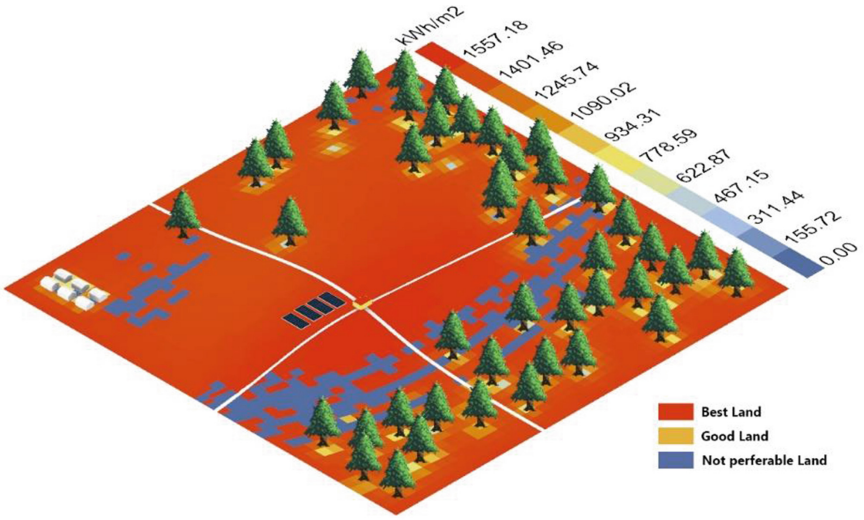

Fig. 2. Top image shows how to calculate the housing, and solar panel location. (by Wang Yueyang)

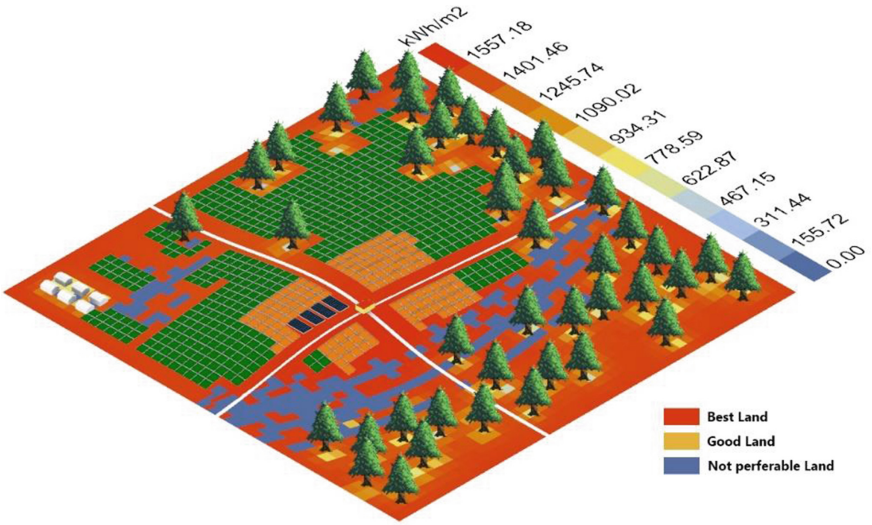

Fig. 3. Final result (by Wang Yueyang)

12 Conclusions

Space data generator has successfully showcased our design aspirations as a whole. This tool has the potential to evolve into an optimized app that can automatically access real-time information, such as global crop prices and the comprehensive impact of soil quality on different crops, to quickly provide universal carbon net zero emission principles [9].

Integration with pixel farming could significantly enhance the efficiency of addressing agricultural planting challenges in regions with low birth rates. This app has the potential to greatly assist farmers worldwide in an intuitive and user-friendly manner. However, researchers can further research and explore how the Space Data Generator can consider different climates, such as in frigid zones and tropical regions, where users' lighting needs may vary. Additionally, Users can enhance the pedestrian circulation and housing design by providing better connectivity between the architecture and essential locations on the site [10] (Fig. 4).

One potential area of improvement in agriculture is the adoption of agroecological practices, such as mixed planting or intercropping, where different crops are planted together to meet diverse agricultural needs. This approach has the potential to enhance eco-efficiency as mixed planting requires less fertilizer and promotes natural pest control. Additionally, mixed planting can improve soil health and biodiversity. Furthermore, this design approach can also be applied in analyzing optimal urban planning strategies, considering parameters such as transportation, economy, visual aesthetics, and energy consumption for lighting. By assigning appropriate weights to these parameters, this approach can serve as a valuable tool in urban design. In conclusion, to achieve greater efficiency and compatibility, developers need to enhance the Space Data Generator's functionality through continued editing and refinement. Regardless of how users use this tool, with further improvements, it can deliver even more efficient functions in the future.

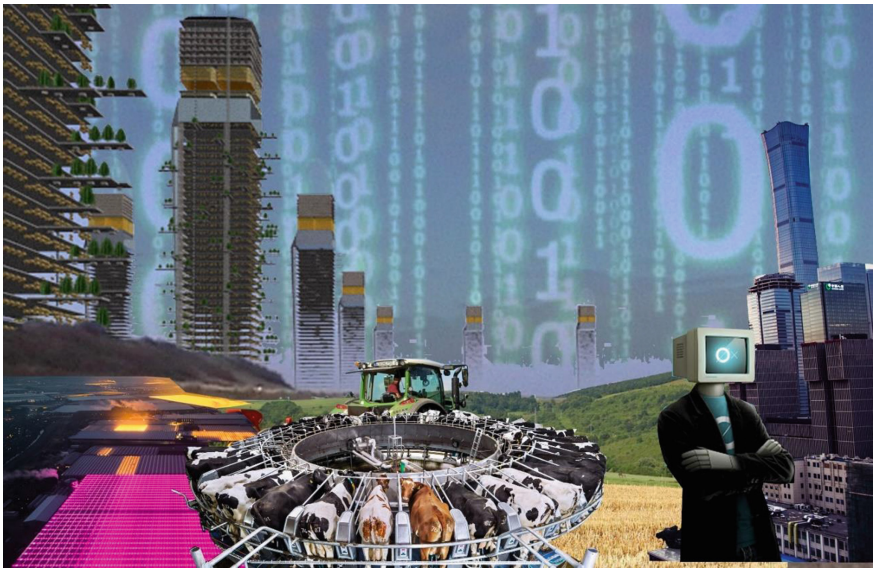

Fig. 4. This image showcases the promising potential of the methodology employed by this app. (by Wang Yueyang)

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