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Review

The Suitability of Prehistoric Human Settlements from the Perspective of the Residents

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Abstract: The study of the suitability of prehistoric human settlements (SPHE) can help us reproduce the process and characteristics of prehistoric human settlements, and is an important entry point for exploring the relationship between prehistoric humans and land. In this study, we discuss the definition, compositional structure, evolutionary mechanism, and spatiotemporal representation of the suitability of prehistoric human settlements, and propose its main research lines and possible research contents. We believe that the suitability of prehistoric human settlement environments refers to the ability and process of natural and social environmental conditions to meet the needs of human survival within a certain spatial range centered on the settlement of prehistoric humans. Additionally, with the temporal and spatial evolution of humans, society, and nature, it shows local consistency and global gradual and continuous change characteristics, and the human settlement environment has a suitability hierarchy of natural original, livelihood, and living spaces nested step by step. We believe that we can adopt the main research line of prehistoric human settlement suitability system construction to conduct extensive experiments and demonstrations on the theoretical construction, the evolution of the environment and living process, the relationship and evaluation of prehistoric human needs, the transformation of the living environment, living adaptation theories and models, and value and limitation verification. Thus, a complete research system can be formed to explore the evolution of the prehistoric human–land relationship.

Keywords: prehistoric human settlements; suitability; definition; system composition; prehistoric human–land relationship

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1. Introduction

The study of prehistoric human behavior is an important part of studying prehistoric human–land relationships and human development. Prehistoric human habitation behavior is the product of prehistoric human production and life practice, and is displayed at preserved residential sites. As the geographical space for the production and life of prehistoric humans, prehistoric residential sites or settlements and their surrounding spaces are the areas with the most frequent human activities, significant human–land interaction, and concentrated space for prehistoric human behavior. Traces of prehistoric human settlements are preserved in the form of residential sites and their burial, along with media such as stone tools, sediments, bones, carbon particles, profiles, starch, phytoliths, and metal objects [1–12], which record information on the natural and social environments of prehistoric human beings. While discussing the biological information associated with residential sites, we must also reveal the functional attributes, spatial combination, and hierarchical structure of the residential site itself [13–15]. In addition, we must clarify the residential choice and attributes of the site, interpret the selection characteristics of prehistoric human settlements, and discuss the suitability of the prehistoric habitat environment (SPHE) of the site. Taking people as the starting point can reveal the impact of SPHE on the development of human society and culture.

Owing to spatiotemporal differences, prehistoric human settlements exhibit diversity in the nature of their dwellings and types of buried objects. Hunting and gathering camps also appeared during the construction of prehistoric [16–18], nomadic (seasonality, mobility) [18–21], and long-term settlements and other types of dwellings. The changes in cave dwellings and half-burrowed, above-ground, and elevated buildings in different environments must also be considered independently of each other [22]. This makes the definition of prehistoric human settlement types uncertain [23,24] and thus transmits this difference to the suitability of residence. The spatiotemporal characteristics of the scale, quantity, and spatial distribution of prehistoric human settlement information provide evidence for the study of prehistoric human expansion and cultural change, and simultaneously reveal the adaptation and transformation of past population settlement behavior and living activities in the environment [25–27].

The combination of site distribution, evolution and environmental background, climate change, livelihood mode, and manual technology has helped researchers to effectively explore the relationship between environmental evolution and social dynamics [10,27–29]. It has also shown that, when prehistoric humans responded to environmental evolution, they used adaptation and transformation to make environmental conditions suitable for their survival. Based on the temporal and spatial distribution characteristics of the site, the interpretation of the influencing factors of the site distribution further reveals the environmental significance of the site selection of prehistoric humans and the complexity of their developmental needs [21,25,30–33]. Site selection activities show preferences for climate, topography, altitude, biological resources, water sources, and social functions, reflecting prehistoric humans' selection of the suitability of the living environment and the ability to withstand changes in the suitability of living [34–37]. All these factors provide enlightenment for the study of SPHE, projecting the interaction and results of the prehistoric human–land relationship. However, current research on SPHE is often conducted as expanded content, as a reference to discuss the possible impact of individual elements. Systematically explaining the internal characteristics and external performance of SPHE is difficult, so the connotation and composition of SPHE, mechanism of action, and other aspects need to be investigated.

Research from different perspectives reflects the needs and practices of prehistoric humans regarding the suitability of the living environment and expounds on the possible influence of environmental factors on it. To meet the requirements of structure and multi-element comprehensive residential choice, more extensive and comprehensive SPHE research is needed to address the existing problems, such as vague definitions, single content, split perspectives, and unclear structures. Therefore, based on previous studies, we discuss the meaning, composition, space–time representation, and relationship of prehistoric human habitation suitability. Additionally, we discuss the operational rules and mechanisms of SPHE to understand the relationship between suitability status and human migration, cultural diffusion, and development of civilizations. Finally, we present views on the research framework and ideas for SPHE research to provide a reference for the evolution of prehistoric human society and the relationship between humans and the Earth.

2. Deconstruction of the Connotation of SPHE

2.1. Composition and Meaning of the Suitability of Modern Human Settlements

The birth of human settlement science laid the foundation for the proposal of the suitability of the human settlement environment [38]. Subsequently, the human settlement environment was understood as collections covering cities, towns, or villages that include social, material, organizational, spiritual, and cultural elements [39]. Five levels of global, regional, urban, community, and architectural investigations were conducted on the aspects of society, economy, ecology, culture, art, and technology [40,41]. In a broad sense, the human settlement environment refers to the surface space closely related to various human activities [41,42]; that is, the sum of all elements related to human activities. From the perspective of correlation, this may be an infinite space; from a narrow perspective, the space of settlement activities in the human settlement environment is a geographical space closely related to human survival activities [42], including physical and non-physical environments.

The modern suitability of human settlements can be understood as "being suitable for, and capable of". For cities, the suitability of human settlements encompasses the five goals of safety, health, convenience, comfort, and inclusiveness [43–47] and should provide a satisfactory living environment for residents on the basis of supporting survival [48]. For rural areas, the suitability of human settlements means that the living environment can support living needs such as sustainable livelihoods, complete infrastructure, convenient public services, and a good natural environment, making rural human settlements suitable for survival and development [49–52].

Modern research on human settlements indicates that they should include four elements: natural environment, spatial pattern, service facilities, and humanistic environment [42]. On this basis, research on the suitability of the living environment is conducted on the natural suitability and evaluation of the quality of the living environment and the satisfaction of the residents. The suitability characteristics of the physical environment and people's subjective cognition are interpreted by focusing on the impact of the living space and evolutionary mechanisms on the suitability of human settlements [41,53–57].

2.2. SPHE Composition and Space–Time Representation

Because of the differences in natural and social environmental backgrounds, compared with the suitability of modern human settlements, SPHE needs to consider the differences in three aspects: social environment appearance, natural environmental conditions, and human needs. SPHE is a product born through human practice in the human–Earth system, including natural environmental components at the material level and social and cultural components at the non-material level. It is not limited to the places where prehistoric human activities were performed, but also to a secondary system composed of environmental adaptation and practical transformation established in the human–land system, which is affected by multiple human, social environmental, and natural environmental factors. With this understanding, we explored the composition and evolutionary dynamics of SPHE (Figure 1).

2.2.1. Social Environmental Appearance

The social environment consists of population development, an economic foundation, health security, technological level, cultural teaching, and other aspects. Compared with modern society, the social development in the prehistoric period was lower. It is difficult to directly record cultural technology, and cultural and technical communication needs to span a wide range of space. After the formation of the prehistoric production technology system mainly based on grinding stone tools, the productivity and prosperity of prehistoric humans improved, and the social complexity, handicraft specialization, and economic structure were affected [58–62].

During this period, the sprouts of human civilization emerged successively in the Yellow, Indus, Nile, Tigris, and Euphrates Rivers. The birth and development of pottery, agriculture, animal husbandry, and metallurgy technology further changed the development of human society [1,6,12,29,30,63–70]. Although the improvement in production technology changed the appearance and level of prehistoric human life to a large extent, compared with modern society, human society in the prehistoric period was still in a primitive state [71]. There is a large difference in the social environment of the modern living environment in economic forms, population status, technological level, ethical aesthetics, and religious beliefs. Therefore, the SPHE social environment assessment should be based on the reconstruction of prehistoric social outlooks.

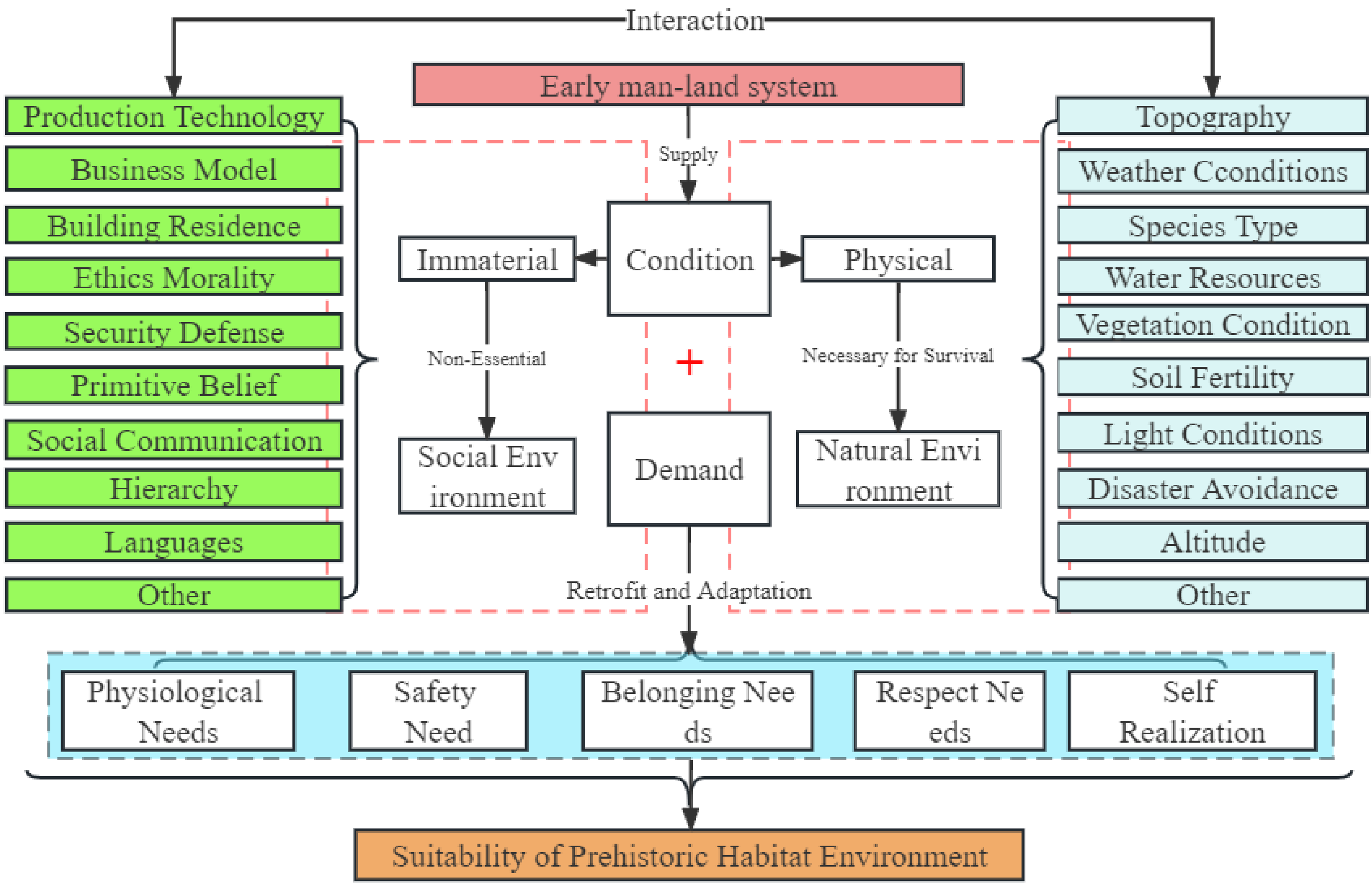

Figure 1. SPHE composition and relationships.

2.2.2. Natural Environmental Conditions

The natural environment is the source of resources for human survival and development, as well as the background of human settlements. The natural environment provides biological and non-biological resources to support human development. During the long process of prehistoric human development, the natural environment also evolved at the global and regional scales [72–76]. To adapt to the changes in resource availability caused by environmental changes, diversified and specialized coping technologies and strategies were developed. The method of hunting and gathering food in human society also changed to comprehensive agriculture and animal husbandry for food production, and the form of human settlement changed from mobile cave dwellings to permanent settlements on the ground [29,60,77–84].

In addition to water and air, during the food gathering stage, prehistoric humans used animal and plant resources (land and sea) obtained by hunting and gathering as their main food source to maintain their living systems. However, the growth rhythm of animal and plant resources and the changes in the natural environment contributed to three types of strategies of hunter-gatherers. The first involved hunter-gatherers moving to the next settlement when the resources within a reachable range around the settlement were exhausted in a living environment that could provide food throughout the year [84–87]. The second was subject to the growth seasonality of biological resources; prehistoric human settlements had a rhythm of consumption that was synchronized with the maturity of biological resources. After the collection was completed, such settlements were relocated and abandoned [86,88–91]. In areas where biological resources had seasonal or other rhythmic growth cycles, the third strategy involved storing the collected food to survive periods of food scarcity, which allowed them to live in a settlement for a long time. Simultaneously, a large amount of food needed to be collected and stored outside of the residential area [92], which also expanded the spatial scope of the living environment and produced base and satellite camps for production attributes, such as transportation, storage, and slaughter [86–94].

As adaptations to different living environments, the above three strategies have a certain degree of mobility in time and space. Temporal fluidity was manifested in seasonal regularity and non-seasonal instability, and spatial seasonal and non-seasonal migration required constant selection and adaptation to new living environments to meet the material needs of survival. To adapt to such temporal and spatial mobility, prehistoric populations employed the most suitable strategy according to distinct environmental characteristics and resource conditions. They utilized one or more mixed strategies to acquire the necessary sustenance and resources within various temporal and spatial settings. These practices significantly enhanced their rates of survival achievement and adaptability. Such adaptation strategies reflected the temporal and spatial instability of the natural support for human survival provided by human settlements during the food hunting and gathering stage, meaning that it was difficult for prehistoric humans to obtain a long-term and stable supply of environmental resources in a fixed geographical space.

In the stage of food production, the development and maturity of agriculture and animal husbandry changed the natural support of prehistoric human settlements. This included extensive domestication of wild animal and plant resources, improving production technology, deepening the selection of the natural environment, maintaining the sustainability of the production environment, and expanding the geographical space for survival and production [29,63,64,95–99]. The formation and development of agricultural and animal husbandry production technologies and systems improved the habitability of the local natural environment, maintained long-term or permanent living environments, and changed the living environment from mobile to fixed. Simultaneously, certain communities embraced a hybrid economic model encompassing both food gathering and food production. This entailed not only relying on the collection of wild resources but also cultivating crops, rearing livestock, fishing, and hunting for sustenance. By adopting this mixed economic model, these groups could compensate for the limitations of food gathering, ensuring a more stable and dependable food supply while still maintaining reliance on natural resources. The implementation of such a blended economic model may have been influenced by various factors, including geographical environment, climatic conditions, and the availability of resources. Consequently, different communities may have leaned towards a food collection-based economic model in resource-abundant regions, while they might have tended to develop food production in resource-scarce areas.

2.2.3. Prehistoric Human Needs

We understand human behavior as all observable internal and external activities of human beings, and behavior is based on needs and motivations. Needs create the motivation for behavior, and motivation induces people to take action to meet needs. Therefore, when we discuss prehistoric human behavior, we are essentially discussing prehistoric human needs. As a psychological dynamic, demand needs to be observed based on the characteristics of human behavior and its products. Therefore, prehistoric human needs must be explored via the remaining products of human activities. Prehistoric human settlements, as the geographical space for common activities and social interactions of prehistoric humans, are the geographical space where human needs were transformed into practical behaviors and the relationship between prehistoric human needs and settlements was recorded. Therefore, SPHE represents the level of satisfaction of needs.

The fundamental link of prehistoric human needs lies in the need for survival, requiring the living environment to meet the three basic physiological needs of breathing, water, and food (Figure 2). The physiological demands of respiration (oxygen demand) directly affect the altitude of the distribution of prehistoric humans, and for most people, the unsuitability of survival in hypoxic environments and slow physical adaptation forced them to mainly distribute at lower altitudes [29,100–102]. As the basis of life, water exists in three states: solid, liquid, and gas. Liquid water is the most used by human beings and is sourced from springs, streams, rivers, and lakes. Different forms of liquid water resources are the basic components of prehistoric human settlements. These have become the core factors affecting the suitability of human settlements [103,104]. The fixedness of respiration and water requirements and the relatively single distribution of oxygen and water resources make SPHE have a wide-area consistency.

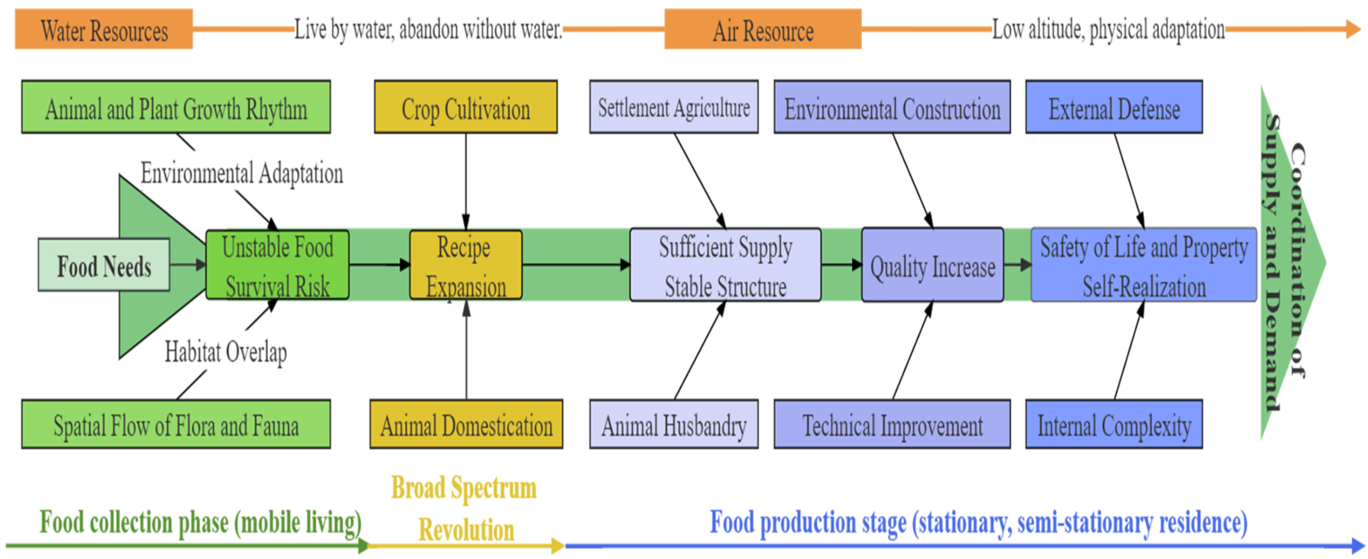

Figure 2. Time development process of main needs of prehistoric humans.

Compared with the above two survival needs, the supply of food resources changes during the process of human development. As shown in Figure 2, in the food collection stage, the food structure dominated by wild animal and plant resources is complex [105–110]. Under the influence of the periodic growth or rhythmic activity characteristics of animal and plant resources [88–91], the human settlement environment needs to match the growth environment of food resources. The habitats of humans and edible organisms are interlaced and overlap, and human survival and development are achieved via passive adaptation. Human niches and habitats changed with those of wild animals and plants, and the natural attribute of the suitability of human settlements was actually the growth suitability of a variety of edible wild organisms [111,112].

However, due to changes in environmental conditions, biological growth rhythms, and the abundance of biological resources, unstable changes in the amount of food collected posed survival risks [88–91], and prehistoric humans gradually shifted their food acquisition to the food production stage. In the stage of food production, domesticated animals and crops became the main source of food, and the satisfaction of food needs revolved around livestock and crops. To maintain the sustainability of agricultural and animal husbandry production, decision-making and adaptation strategies aimed at minimizing costs and maximizing production output were developed. The production of agriculture and animal husbandry resulted in a reduction in the cost of space movement, the food supply having high reliability and a large output, and the mobility of living being low, which promoted gradual settlement. Therefore, the living environment was fixed within a certain spatial range.

The relatively fixed living space provided conditions for prehistoric humans to transform the living environment. To further improve the reliability of the food production system and reduce the cost of survival, the demand for large-scale, high-density, and multi-variety production forced prehistoric humans to consciously cultivate and transform the means of production. On the one hand, prehistoric humans expanded and optimized domesticated species, transformed the ecological niche of wild animal and plant resources, and enhanced the quality and quantity of planted and raised species to ensure the stability of germplasm structure. On the other hand, transforming the living environment, building a production environment that met the needs of livestock and crop niches, developing arable land, selecting pastures, and improving technology reduced the cost of spatial movement and uncertain risks in production. At this time, domesticated animals and crops were added to the composition of prehistoric human settlements. Thus, the natural attributes of the suitability of human settlements became the growth suitability of domesticated crops and animals, and meeting the production needs of prehistoric food resources became the key to the adaptability of human settlements.

After the food needs for survival are met, other needs can become new motivating factors. According to the hierarchy of needs theory [113,114], as autonomous organisms, prehistoric human life and property safety became a new driving force for the transformation of human settlements. In the stage of food collection, the unstable physiological supply–demand conditions made safety a lower priority. In the stage of food production, the importance of safety demand was enhanced and became one of the main driving forces for the adaptation and transformation of human settlements. Prehistoric humans faced and responded to external intrusions—such as conflicts between different groups, disasters, and wild animal attacks—and internal structural instability risks, such as diseases, distribution of power, class conflict, and cognitive differences [115–125]. Safety and suitability (defensive) strategies and practices were implemented in human settlement environments, artificial ditches and walls were constructed, highlands and disaster avoidance sites were selected, and the complexity of social relations was gradually realized [126–132]. Thus, the improvement in the suitability of the human settlement environment was diversified.

Simultaneously, we need to note that the structure of human needs is complex. Most of the time, human behavior is the result of the combined influence of many needs [114]. Various needs provide various motivations for selecting the suitability of human settlements, which also makes the change in human demand behavior occasional. This means that the needs of prehistoric humans did not necessarily develop according to the above-mentioned two stages of food collection and production. It is possible that in a certain period of time, the satisfaction of survival needs stimulated other needs and acted on the construction of human settlements in a practical way.

2.3. SPHE Meaning

Previously, we expounded on the definition and main components of modern human settlements with the aim of gaining a deeper understanding of the definition and composition of prehistoric human settlements via differences and comparisons. Compared with modern human settlements, prehistoric human settlements differed in three aspects: social environment, natural environment, and human needs. Therefore, the definition of prehistoric human settlements cannot be applied to the definition of modern human settlements. We believe that prehistoric human settlements focused more on the survival needs of prehistoric human development. Under the relatively fragile prehistoric social self-sustainability, the social and natural conditions for maintaining human survival were unstable, so uncontrollable variable factors and low human social adaptive ability put the sustainability of human survival at risk. This is evidenced by the remarkable correlation between the decline and demise of prehistoric human cultures and the deterioration of natural environmental conditions [34–37], despite the efforts of prehistoric humans via technological and migratory adaptations [133–136]. In modern society, the relatively stable natural environment, highly developed productivity system, complete social organization, and control strategies have extensively solved the problems of human survival. In turn, modern humans have more opportunities to develop other needs, so the pursuit of living has become the pursuit of how to live.

Therefore, we believe that SPHE required a balance between the survival needs of prehistoric humans and the supply of natural and social conditions in the living environment. In other words, SPHE refers to the ability and process of the natural and social environmental conditions to meet the living needs of human beings within a certain spatial range centered on the settlements of prehistoric humans.

3. Spatiotemporal Representation of SPHE

3.1. Time Course of SPHE

More primitive cultures are more affected by the ecological environment, while more advanced cultures are less dependent on the environment [137], which is also true for SPHE. With the gradual progress of human civilization, based on the prehistoric human–land system, prehistoric human individuals or groups selected and modified settlement environmental conditions under the guidance of the psychology and needs of maximizing survival utility and benefits. We define the process and result of this supply and demand selection as SPHE. Among them, the demand for the living environment is predetermined by the material needs for human survival, such as food, breathing, and heat. The fixedness (immutability and necessity) of such material needs forced human settlement activities to exist only in some specific geographic locations, form similar ecological niches, and have a strong geospatial correlation [138]. Especially in the early stage of productivity development, when the ability of human beings to modify the environment was limited, the SPHE produced a certain degree of consistency. In addition, the partially identical or similar livelihood patterns further enhanced this consistency feature.

Along with human production and social progress, the satisfaction of material needs promotes the birth and development of spiritual needs. Simultaneously, the distribution range of prehistoric humans expanded, and the heterogeneity of geographical space was prominent [139]. During the continuous migration process, humans continued to optimize the living environment with practical actions to maximize the supply level and efficiency of public goods in the living area, which changed in suitability. Therefore, with the spatial changes in human migration and residence in the evolution of human civilization, SPHE also showed spatial diversity and differentiation. Because of the influence of the consistency of suitability and the continuity of cultural diffusion on residential location selection, the spatial characteristics of this suitability also satisfied the characteristics of transitivity and gradual change. However, during several migrations, the satisfaction of material needs created new spiritual needs, which in turn guided the transformation of the material world and promoted the generation of new material needs until they became relatively stable (Figure 3). However, supplementary factual data are still lacking in the current literature. Long-term series and simulations of multi-scale suitability evolution and verification are needed, and the formation and mechanism of SPHE still need to be determined in research of key time–space sections and typical cultural types.

3.2. Spatial Hierarchy of SPHE

Compared with the long development process of prehistoric society, the living process of a certain prehistoric group is short and limited, and the construction of a relatively stable living environment and its impact are produced within a limited space, usually centered on the settlement. Activities are performed within the shortest distance to obtain the required resources, and the spatial distance of this specific range is generally kept within 10 km from the settlement (2 h on foot) [140,141]. The establishment of satellite camps (including seasonal camps) outside the settlement expands this spatial scope [86–94]. The daily footprints of human beings in a certain residential area are distributed in a network around the settlement and camp, and the actual occupation and utilization of the surrounding environmental resources are achieved via food collection and production, forming a resource domain for living, and reducing the time and space cost of living via technological adaptation.

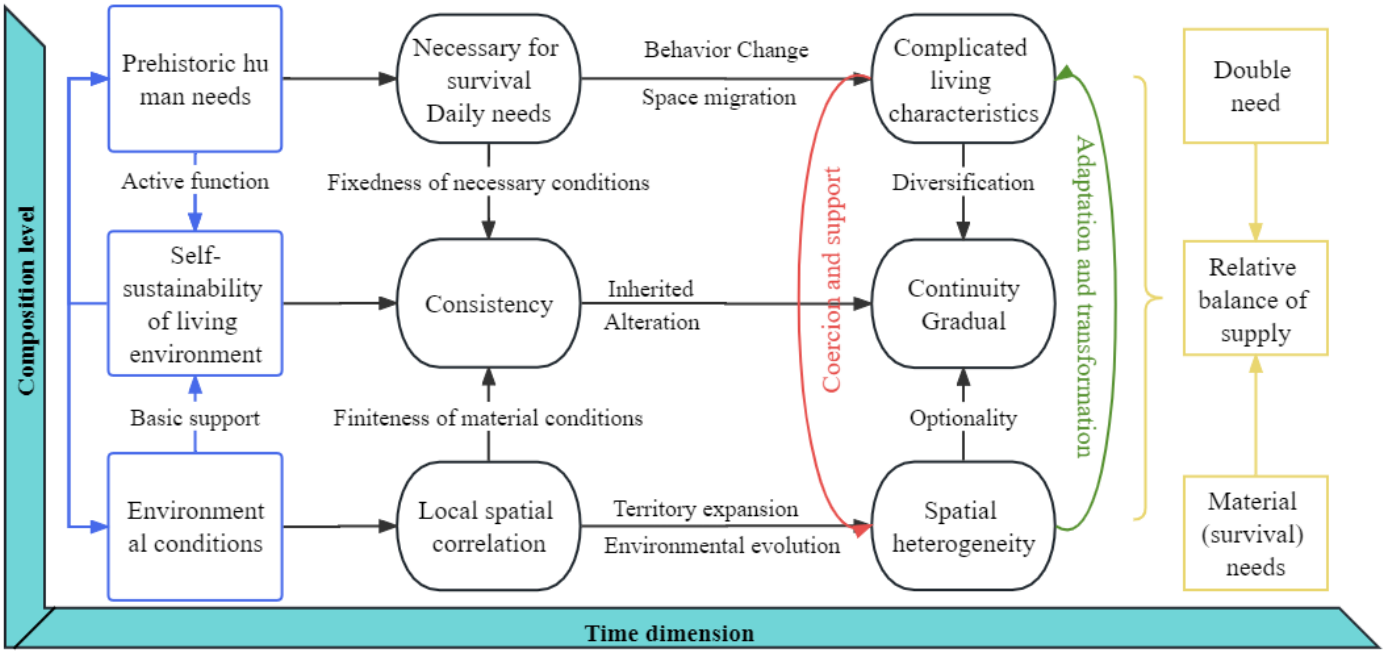

Figure 3. SPHE formation and evolutionary mechanism.

Based on the differences in the function of use and space–time costs [142–145] oriented towards residential needs (providing shelter) and production needs (providing survival materials), the residential environmental space can be understood as two parts, which are the living space with the residence as the entity and the livelihood space with the resource domain as the main body. The residential environmental space is surrounded by natural original space, which is combined into a hierarchy of spatial ranges from large to small (Figure 4). The selection and adaptation of living and livelihood spaces to natural environmental conditions are consistent on a macro level. The living space needs to adapt to local environmental characteristics for individuals. Thus, in terms of form (caves, cave dwellings, half-burrowed, above-ground, and high-rise buildings), size (area), and location, the suitability of the living space is determined by the completeness, comfort, and safety of the facilities provided by the living space and the effectiveness of shelter.

Due to differences in periods and modes of living, the living space needs to be oriented to different food carriers: wild animals and plants, domesticated animals, and cultivated crops. The living space is selected and constructed based on the ecological niche of the food carrier, and the suitability of the living space is determined by its ideality, the adequacy of the quantity, rationality of the species structure, sustainability of the survival of animals and plants, and convenience of acquisition. The living space constructed by the spatial difference of food carrier ecological niches is divided into differentiated spatial ranges by the ideal living space of different food materials. With the living space as the center, a three-layer staggered livelihood space of cultivated crops + domesticated animals, domesticated animals, and wild animals and plants is formed, corresponding to the spatial scope required for the development of three different livelihood modes of agriculture, animal husbandry, and hunting and gathering. Then, three different habitat suitability results of livelihood space are obtained, which constitute SPHE with the suitability of the living space.

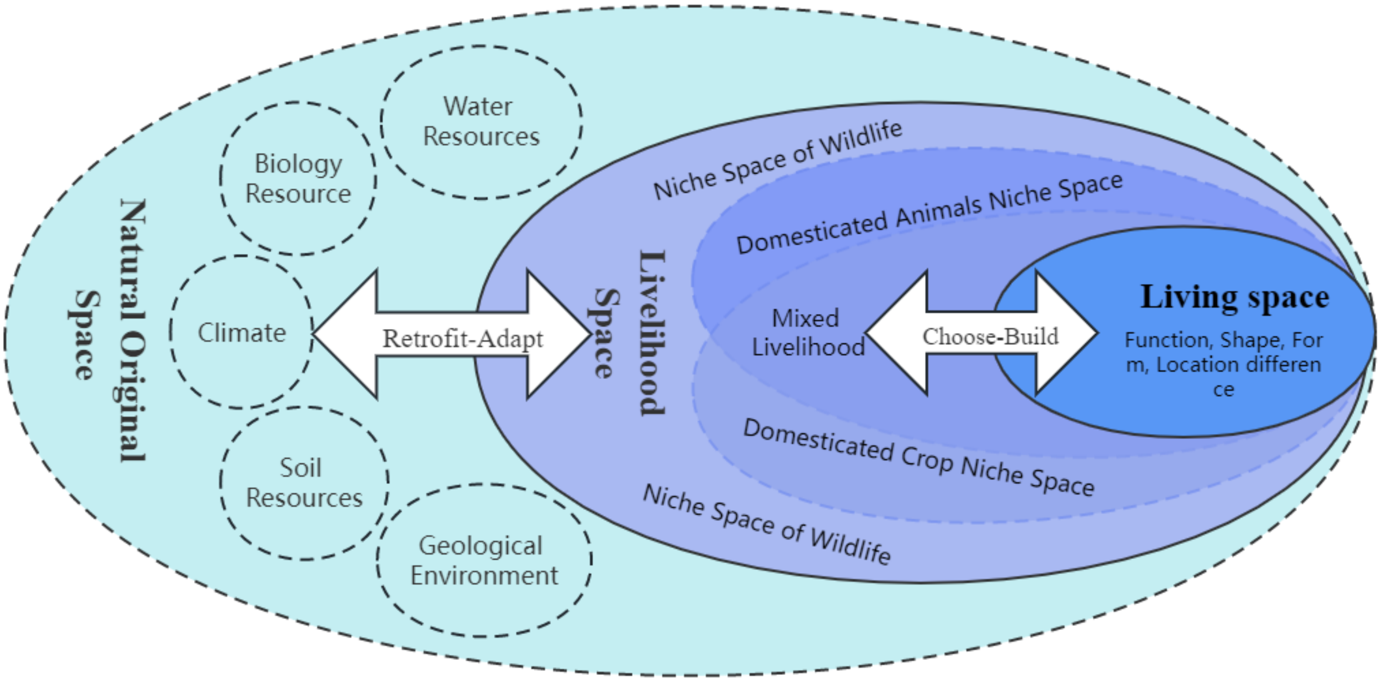

Figure 4. Spatial hierarchy of prehistoric human living environment.

4. Discussion

4.1. SPHE Research Main Line and Content Framework

Previously, we discussed the meaning, composition, and space–time representation of SPHE. We believe that SPHE research should never be separated from the human–land system theory and multidisciplinary theories and technologies should be applied, with the suitability of the prehistoric human living environment as the starting point and the dynamic relationship of the human–land interaction as the core. The evolution and reconstruction of the ancient environment should be combined with the development of human civilization, showing the environmental conditions and social outlook at different time points to restore the natural and social conditions of prehistoric human habitation. Additionally, the stage characteristics of prehistoric human behavior development should be combined with living and production behaviors, the demand development process of prehistoric humans and social evolution should be established, and production should be determined based on demand. Based on environmental determinism, combined with environmental probabilities, the mutual adaptation and transformation of the environment, society, and people in the process of prehistoric human habitation can be extracted, highlighting the resilience of SPHE.

In the face of comprehensive and diverse living forms, environments, livelihood patterns, and temporal and spatial differences, it is necessary to switch perspectives from different types of temporal and spatial scales to the research theme of the interactive relationship between residential environment performance and residential choices. Then, "SPHE system construction—environmental evolution and residential process reconstruction—demand and adaptive behavior—suitability evaluation—multi-scale representation and characteristics—drive and mechanism—type and model—value and meaning" becomes the main line of research. Furthermore, it is necessary to systematically conduct SPHE system structure and theoretical expansion, natural–social condition reconstruction, and prehistoric human settlement selection process and type identification. The suitability evaluation criteria and methodological system should be improved based on environmental reconstruction, the regional and temporal characteristics of adaptation and transformation should be revealed, the transformation and driving mechanism of SPHE and its value and significance should be explored, and the spatiotemporal types and models of SPHE should be refined.

Thus, a complete research system can be formed that includes principle guidance, fact accumulation, phenomenon description, hypothesis verification, and complete value (Figure 5). This, in turn, can reveal the developmental, evolutionary, and regional characteristics of human living choices under different environmental conditions, time and space scales, and cultural backgrounds. Additionally, it can scientifically identify the impact of factors such as early human evolution, technological progress, social organizational development, environmental evolution and mutation, survival adaptation, and livelihood mode changes on the suitability of human living environments. The interaction relationships of SPHE development must thus be discussed in time and space to further understand the response mode and interaction process between human beings and environmental changes.

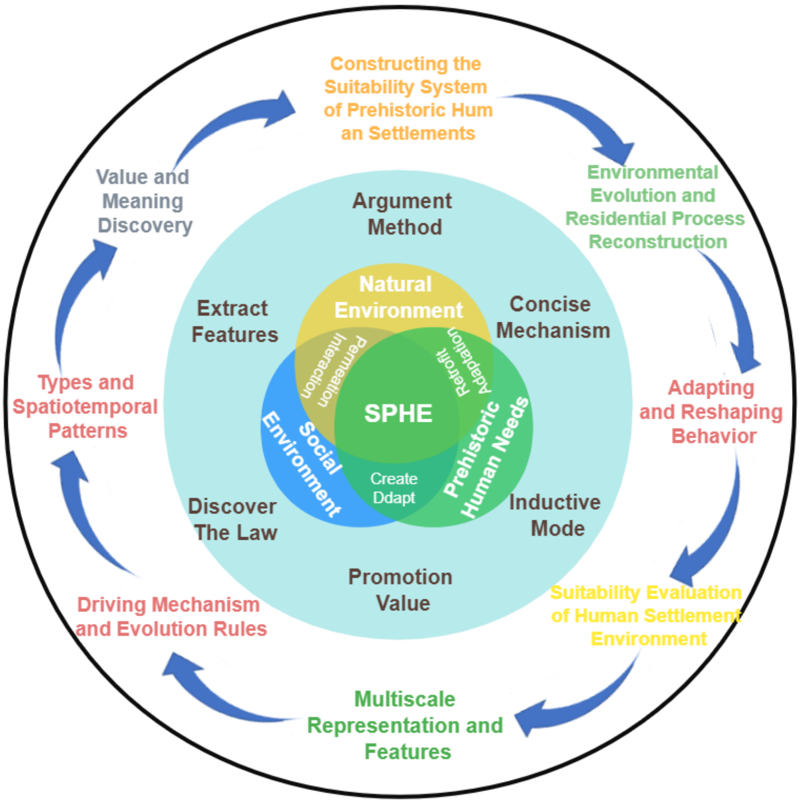

Figure 5. SPHE main research line.

Based on the current relationships between prehistoric human habitation choices and environmental evolution and field investigations and experimental analyses, it is necessary to take a comprehensive cross-disciplinary perspective and integrate the theories and methods of geography, sociology, archaeology, anthropology, ecology, landscape, and other disciplines. From the logical level of theoretical analysis–practice testing–application promotion and using the technical systems of environmental reconstruction and landscape simulation, the demand interpretation and behavior identification, qualitative induction and quantitative measurements, and supplementary data, theoretical, and technical systems of SPHE, as well as the construction of environmental, behavioral, and residential address data systems and completion of the applicability demonstration and regulation of demand screening methods, landscape reconstruction methods, suitability evaluation methods, and spatiotemporal comparison methods must be used to achieve the goals of complete methods, clear features, concise mechanisms, model norms, discovery of laws, and value promotion. This can then answer the questions of why and how, provide application results, and complete the discussion on the evolution of prehistoric human–land relationships using SPHE as the carrier.

Based on the main research line, we sorted the research content of SPHE (Figure 6) and believe that the main research content may include the following points:

1. Theoretical construction of SPHE. This requires the further expansion of the theoretical framework of SPHE, improving the connotation interpretation, concept statement, hypothesis verification, compositional structure, operational mechanism, factual data accumulation, technical system, and value function demonstration of SPHE. Additionally, it should include an expansion of the guiding ideology, theoretical reserve, and technical composition of SPHE with different research perspectives, needs, and subject backgrounds, building the superstructure of SPHE and improving its applicability and scientific nature.
2. Research on the changing characteristics of environmental evolution and habitation process. This should include focusing on the study of the natural and social environmental living conditions caused by the evolution of the environment and human civilization at different time and space scales; that is, changes in human living space and production, food, and social resources. It is also important to discuss the differences in the forms, types, and stages of human settlements, such as residential forms, production technologies, and livelihood, migration, and social organization patterns in the process of human settlements caused by differences in living conditions. Based on this, the change in housing demand and its general manifestations caused by this change under multiple scales (time, space, and cultural type) can be summarized and key characterizations extracted.
3. The relationship between the development of prehistoric human needs and the suitability transformation of human settlements and its suitability evaluation system. This involves systematically studying the adaptation forms and transformation approaches of human residential behavior to human needs and natural and social environmental conditions at different scales, and interpreting the connotations of technological, migratory, and cultural adaptations of residential activities due to changes in demand [133,135,136]. Furthermore, the regionality and stage of the residential adaptation process should be discussed, and the key manifestations and quantitative approaches of residential adaptation extracted. It is also necessary to establish SPHE evaluation criteria and objectives, verify interdisciplinary evaluation systems and methods, and interpret suitability classification standards from the perspective of human–land interactions, based on the environmental background combined with the performance elements of human initiative. In addition, we must study the relationship and driving mechanism of paleoenvironmental evolution and reconstruction and the development and progress of human civilization with prehistoric human habitation activities and suitability evolution, build an environmental evolution model and suitability development stages, and explain the multiple driving mechanisms on multiple scales.
4. Residential adaptation theory and suitability distribution models. Based on developing the above studies, it is necessary to sort the temporal and spatial characteristics, trends, and driving-force mechanisms of prehistoric human living preferences in different natural environments, temporal and spatial scales, and cultural backgrounds. Additionally, the human–land interaction relationship must be refined in the context of early human–land relations. From the two dimensions of passive adaptation and active transformation of human habitation, the theory of early human habitation adaptation and the occurrence mode of suitability preference under multiple scales can be summarized.
5. SPHE application value verification and limitation research. Based on the evolution of prehistoric natural and social environments, extensive SPHE evaluation and process discussion should be conducted. We need to use multi-parameter dynamic regulation to simulate the dynamic process of SPHE and use space–time comparison and dif-

ference verification to demonstrate its space–time application scale, problem-solving utility, and limitations in the study of prehistoric human–land relationships. In addition, it is necessary to accumulate data, determine the influencing factors and technical methods, and screen the obstacles and strengths of theoretical frameworks based on application limitations. In this way, feedback can be formed to improve SPHE theory, logic, methods, and data construction, and promote the application value.

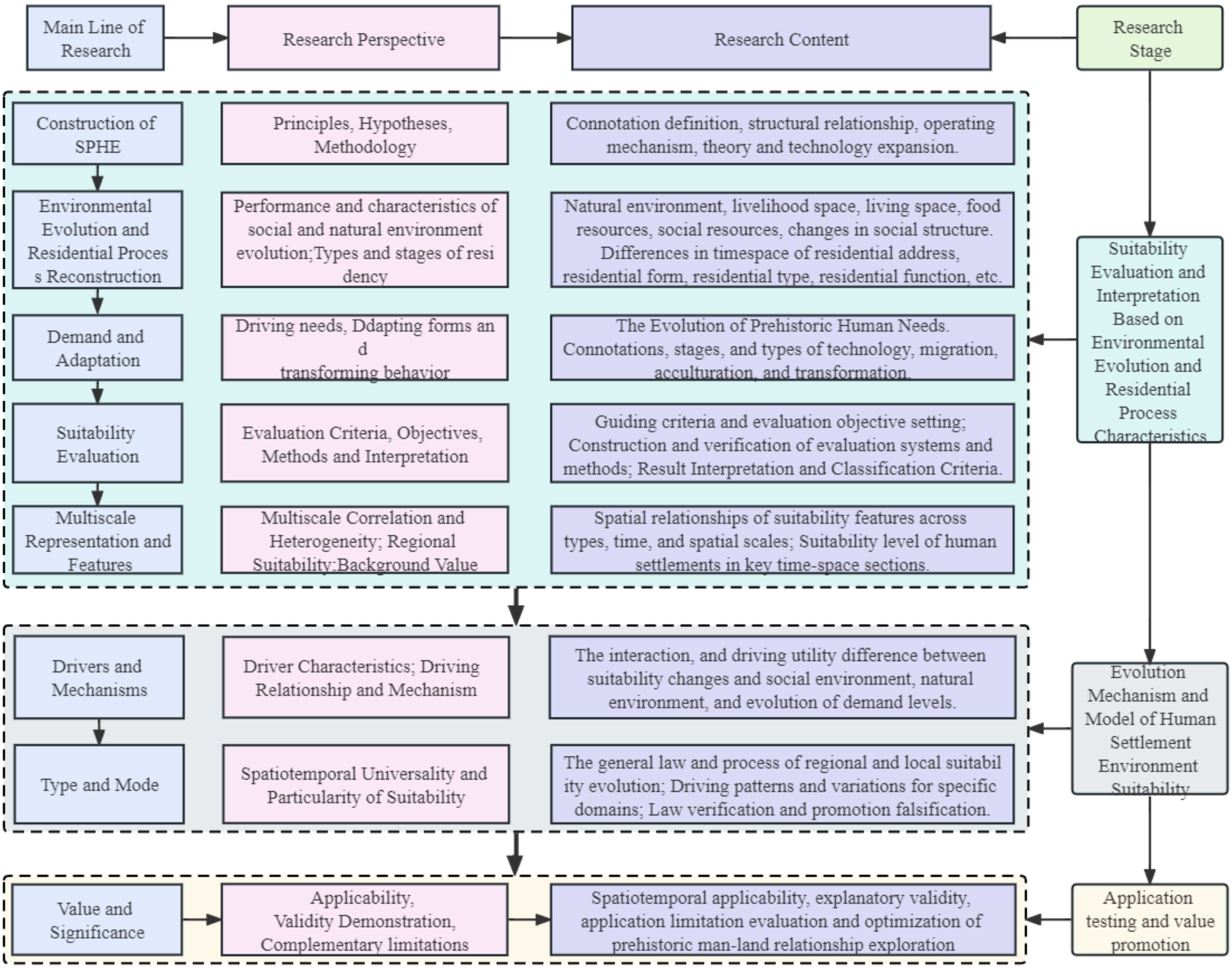

Figure 6. SPHE research framework and content.

4.2. The Limitations and Uniqueness of SPHE

In the process of studying SPHE, we have to note that the effectiveness of environmental suitability for prehistoric human habitation may vary over time scales. Compared to the agricultural and pastoral economic periods, archaeological data from the hunting and gathering phase are relatively scarce. Archaeological sites from the hunting and gathering phase were typically located in outdoor environments and exposed to erosion and destruction by natural elements, which made the preservation of ancient remains difficult as the passage of time and the forces of nature could lead to the destruction and disappearance of these sites. This further results in the scarcity of material cultural remains of human communities during this phase, such as buildings and pottery, making researchers face greater challenges in acquiring and interpreting data. Due to the uncertainty of dating and the scarcity of archaeological materials, it is difficult to determine the exact chronology of specific sites and artifacts as well as the information they reflect. Therefore, we can only rely on limited locations and specific samples for study when assessing the suitability of prehistoric human habitation during the hunting and gathering phase, which may induce geographical limitations and sample biases, thus increasing the uncertainty of conclusions.

At the same time, the complexity of the interaction of multiple factors such as environmental changes, cultural differences, and diversity of human decision-making over a long period makes it more difficult for us to study SPHE. Lost cultures and social organizations prevent us from directly observing and testing the decisions and behaviors of ancient humans, forcing us to retrospectively infer the environmental choices and adaptation strategies of prehistoric humans. Therefore, it inevitably involves speculation and assumptions, which influence our understanding of prehistoric human behavior and decision-making. Although the application of SPHE in the hunting and gathering stage of ancient humans is subject to multiple limitations, as an exploration, the concept of SPHE can be applied to known hunter-gatherer populations and sites. Using existing materials and information, we explore the decision-making process and behavioral characteristics of hunter-gatherer people, and evaluate the suitability of their living environment, providing possible references for the study of early human decision-making and behavior.

In this article, the concept of SPHE emphasizes the interaction between humans and the environment, especially the impact of the environment on human settlement and livelihood patterns. It focuses on understanding why humans choose to inhabit specific geographic environments and adopt specific economic patterns and forms of social organization. This concept holds that prehistoric humans chose settlement locations and livelihood methods based on their adaptability to environmental resources and conditions; that is, what needs they satisfied. The interpretation of the development process of prehistoric human behavior, needs, and adaptive behaviors in a long-term sequence, and the extraction of the continuity and adaptability of SPHE from the perspective of needs, allows us to study and compare similarities and differences between different cultures and social formations.

In contrast, the concept of "settlement pattern" focuses more on the study and analysis of the layout and organization of settlements in prehistoric times [10,14,26,146–148]. The settlement model is based on information such as the geographical distribution and architectural structure of archaeological sites and attempts to reveal the organizational structure and developmental dynamics of prehistoric human society via the study of similarities and differences between settlements. For example, settlement patterns can reveal the types of settlements (such as villages, cities, fortresses, etc.) in different periods and regions, the layout and form of residential units [26,148], and the mutual relationships between residential units [14], which help archaeologists determine the characteristics of prehistoric humans in terms of social organizational forms, division of labor, and economic activities [10,14,149,150].

Although SPHE and settlement patterns are related to some extent, they focus on different aspects. SPHE emphasizes the interaction between human beings and the environment, highlights human initiative, and focuses on exploring the adaptability of prehistoric human needs in choosing residential locations and livelihood methods. The settlement model focuses more on the organizational form of archaeological sites and the revelation of related social information. The simultaneous application of these two concepts can provide a more comprehensive and in-depth understanding of the patterns and dynamics of prehistoric human societies. Although many limitations remain in our statement and discussion of the concept of the suitability of prehistoric human settlements, as an exploration, we hope to apply the concept of SPHE and combine it with other methods and technologies to increase our understanding of prehistoric human settlements and lifestyles and achieve theoretical refinement in the process.

5. Conclusions

The study of SPHE and related issues is an important entry point for exploring the prehistoric human–land relationship. We discussed the definition, compositional structure, evolutionary mechanism, and space–time representation of SPHE, and proposed its main line and possible research content. We believe that SPHE is the ability and process of coordinating the natural and social environmental conditions to meet the needs of prehistoric human survival. It is a relatively balanced state formed in the interaction between humans and land, and it shows local consistency and global gradual and continuous change characteristics with the temporal and spatial evolution of humans, society, and nature. Under the dominance of space–time cost and use functions, prehistoric human settlements had a hierarchical structure of natural primary, livelihood, and living spaces. In later studies, we believe that, in an interdisciplinary context, we can use the main research line of SPHE to determine and perform system construction, environmental evolution and residential process reconstruction, needs and adaptive behavior, suitability evaluation, multi-scale representation and characteristics, driving mechanisms, types and models, value, and meaning. Then, a wide range of experiments and demonstrations can be conducted on the theoretical construction, evolution of the environment and living process, relationships between and evaluation of the needs of prehistoric humans and transformation of the living environment, theories and models of residential adaptation, and verification of values and limitations. Finally, a complete research system can be formed via the accumulation of theories, data, technology, and value for exploring the interaction process between early humans and the environment, and for revealing the evolution of their relationship during the long civilization process.

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